COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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PUTTING THE SIPHON THROUGH

Up at the Storm King Canon they're working us day and night;
We've got our standard to hold to, we've got contractors to fight;
We live in boots and a slicker, we sleep when we get the time,
And our faces and hands are plastered with stickiest hard-rock grime;
We're too dog-tired for drinking, too sleepy to touch a card;
Our talk is all of the siphon—of rock that is soft or hard.
The wise guys laughed at the project; they said it would "never do"!—
But up at the Storm King Canon we're putting the siphon through!

We sunk a shaft in the mountain, where only the goats had played—
Where you had to hang by an eyelash to handle a pick or spade.
A shaft went down by the river—and the water commenced to pour;
And we plotted a plan to plug it—for that's what our pay is for.
We diamond-drilled on the bias, we sunk a shaft in the silt,
And sometimes the cold would numb us and often the heat would wilt.
We sought bedrock for ages and finally got a clew—
And down at the 'leven hundred we're putting the siphon through!

A seam was struck in the heading, far under the river-bed;
The water filled up the working and all of the runners fled.
But the pumps were set to going—we made a bulkhead to block;
And now once more the drillheads are battering at the rock.
The "hard-rock" gang were peaches—they entered into the game,
They laughed at the thought of danger, they took each chance as it came;
And, though there were politicians who tried to hand us a few—
Up at the Storm King Canon we're putting the siphon through!

It's tough—but it sure is worth it; it's rough—but it's bully fun
To do the thing that the wise guys have prophesied can't be done;
And when the job is over and the water is rushing in,
Why—then is our chance to chuckle and then is our hunch to grin!
The stream will come from the mountains and into the thirsty town,
And we will have done our portion of bringing the water down;
So what if the work is wearing and things will go askew—
Up at the Storm King Canon we're putting the siphon through!

—Berton Braley in *Saturday Evening Post.*

PNEUMATIC AUTOMOBILE STARTERS

It is quite remarkable that the inconvenience, the labor and the danger of cranking the automobile for starting have been so long tolerated, and undoubtedly the greatest of recent improvements in gasoline cars has been in the quite general addition of some starting device. There are now in the market a half dozen of these devices, and it may well be believed that before long no machine will be built without one.

H. W. Perry, writing in *Motor,* says that

the only type of starter which has passed the test of service in the hands of private users is the pneumatic, and it is not certain this originated in the United States or in Europe. The Saurer cars and trucks built in Switzerland and exhibited and sold in New York and Chicago in 1907, were provided with well designed air starters having all the essential features of the latest ones announced. Winton cars, which have for many years possessed an air control system as a distinctive feature, were fitted with automatic starters of the pressure type last year, and these have been continued and are one of the talking points of the Winton sixes for the coming year. Recently the Chalmers Moto Co. announced that its Chalmers-Detroit 36 horse-power medium-priced cars would be equipped regularly with compressed air starters. The Simplex Motor Car Co. and the Metzger Car Co. have also adopted starters of the same class for their 1912 Amplex and Everett models.

These several makes of starters are much alike in their main features although each is made exclusively for the cars on which it is used. In all of them the motor is utilized to produce pressure in a storage tank carried under the car. By pressing a push valve on the dash with the foot, the air or gas under pressure is released and passes through a distributor which is geared to the motor to act in synchronism with the pistons. The function of the distributor is to admit the air successively to the cylinders in which the pistons are on the working stroke. The pressure forces the pistons down, causing the other cylinders to draw in charges of fresh gas through the carbureter until ignition occurs and the motor runs on its own power.

In the Winton system, each of the middle pair of cylinders is fitted with a check valve communicating with the combustion chamber so that at each working stroke of these cylinders a small quantity of gas at high pressure passes through the valves into the storage tank. The Chalmers has a single check valve on the head of one cylinder. It is water-jacketed and serves to force air into the tank until a pressure of 150 pounds per square inch is attained, when the valve ceases to operate. Pumping valves actuated by pressure from the cylinders are also employed in the Amplex system, but they are positively controlled by a valve on the dash which is opened when pressure in the tank becomes low. The compressor used on the Everett cars is of the same general type but is not air cooled. In the several systems the pressure in the tank is indicated at all times by a gauge on the dash. All cylinders of the motor are connected with the distributor by copper or brass leads. Connection with the combustion chambers is by means of valves so that when the motor is running under its own power no gas will be forced back to the distributor.

The Chalmers and Everett distributors contain a metal disk revolving in a horizontal plane. A slot in the plate uncovers successively four holes (or six for the Everett six-cylinder model) through each of which air is admitted to one of the pipes leading to the cylinders. The distributor is so timed with the camshaft-gear that the slot in the disk passes over the holes in the order in which the cylinders fire, the air passing first to the cylinder that is on the working stroke.

The only time when this system will fail to start the motor is said to be when the motor stops on dead center, which cannot occur with a six-cylinder motor and but rarely with one in which the crankshaft is offset. It has the advantage, on the other hand, of getting the moving parts in motion before the first explosion occurs, as in hand cranking, thereby relieving the motor of whatever slight shock there may be incident to starting on the spark. Another decided advantage is that by connecting a rubber hose by valve to the tank, the pressure can be utilized for inflating tires, as in the Chalmers and Winton systems.

AN ABSOLUTE PRESSURE VACUUM GAGE

The vacuum gage here illustrated was described in a recent issue of *The Engineer*, London, the names of inventor or maker not appearing.

Engineers who have charge of large power stations in which steam turbines are used know how necessary it is that the vacuum gauges connected with the condensing plant should register correctly, for a variation of 1 in. in the vacuum has a substantial effect on the steam consumption of the turbines. The ordinary vacuum gauge has one great drawback for this class of work. It makes no allowance for the variations of the barometric pressure. Hence a vacuum gauge may indi-

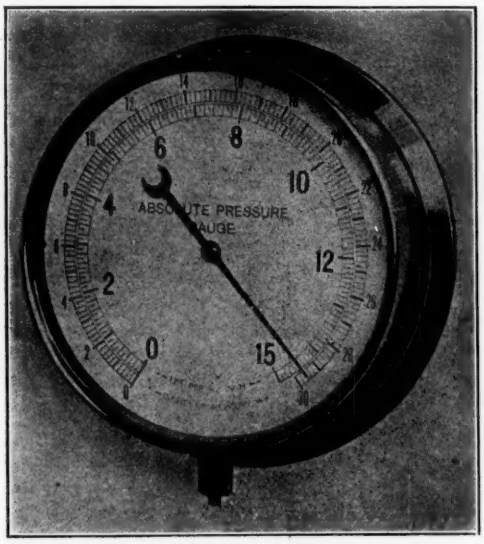

FIG. 1.

cate at one time 28-in. mercury and shortly afterwards only 27-in., and yet the absolute pressure may have remained unaltered, the change being simply due to a drop in the atmospheric pressure of 1-in. The engineer-in-charge has therefore, in such cases, to refer to his barometer and make a calculation.

The gauge, shown in Fig. 1, has been designed to obviate the use of a second instrument and the attendant trouble of calculating the absolute pressure data at each reading. It consists essentially of two sensitive Bourdon tubes coupled in such a manner as to oppose each other in their action. The inside of one of the tubes is in communication with the inside of the condenser, or other chamber from which the air has to be exhausted, whereas the outside is open to the atmosphere. This tube is therefore actuated by the difference between the atmospheric and absolute pressures in the condenser. The second tube is evacuated and hermetically sealed, and is therefore actuated only by the changes of atmospheric pressure; so that if the absolute pressure in the condenser increases from, say, 2-in. to 4-in., while the atmospheric pressure remains the same, the finger of the dial will be advanced accordingly and 4-in. absolute pressure will be indicated. If, on the other hand, the absolute pressure in the condenser increases from, say, 2-in. to 4-in., while the atmospheric pressure falls 1-in., the increase of pressure inside the tube would be 2-in. and the pressure outside the tube would decrease 1-in., and the resultant motion imparted to the pointer in an ordinary gauge would correspond to a change of 3-in. As, however, in the gauge we are describing the atmospheric pressure acts also on the outside of the evacuated tube, the fall in this pressure of 1-in. mercury will cause the tube to expand and thus oppose the action of the vacuum tube to the extent of 1-in., and the resultant motion transmitted to the pointer will be equal to 2-in., and an indication of 4-in. absolute pressure will be recorded on the gauge.

It will be observed from the accompanying sectional drawing, Fig. 2, that the two opposing tubes B, C are not coupled direct to the

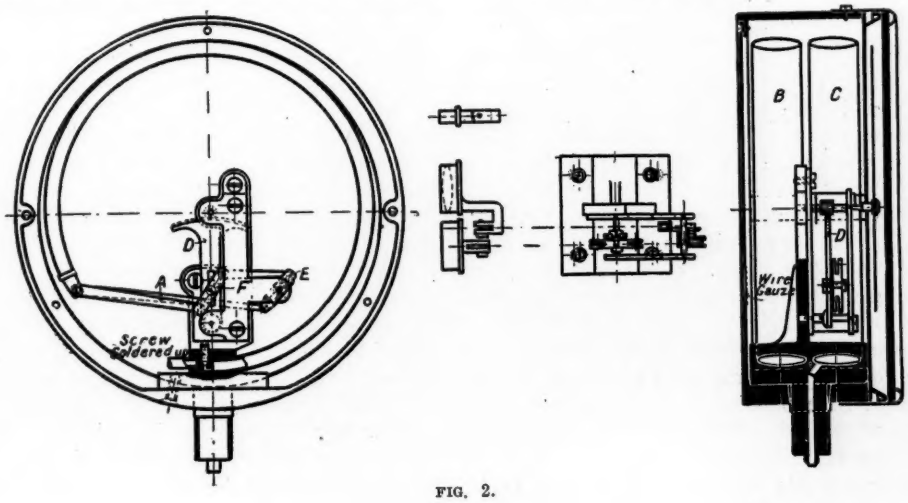

FIG. 2.

quadrant D of the gauge, but their action is transmitted by a special compensating link motion A, which removes the difficulty of the operating tube having to overcome the effect of the elasticity of the other tube, and avoids at the same time the friction which would be produced by the two tubes acting on one pinion in opposite directions. Both tubes are fitted and soldered into a common body and closed at their free ends by end pieces. The front tube C is in communication with the screwed shank at the bottom of the gauge, whilst the other is evacuated and hermetically sealed by means of a screw closing up the passage to the tube. Both the screw and the connection for evacuating the tube are further soldered up as an additional safeguard. To economise space the two tubes are arranged one behind the other, and in order to obtain the opposing effect desired for the barometric correction the movement of the barometric tube is reversed by means of a double lever E pivoted to an arm on the standard. The movement of the two tubes is, moreover, not transmitted direct to the quadrant of the gauge, but by means of a double lever F, or link turning about its centre on a pivot bolted to the quadrant, which latter is slotted to allow of adjustment of the leverage. Besides reducing friction this arrangement enables each tube to move with freedom without straining the other.

STEAM DRIVEN AIR COMPRESSOR ECONOMIES

By E. C. Sickles.

During the past it has been the practice to give but little attention to the cost of operation in the medium-sized compressed-air plants, and in some cases this holds true for the larger plants. First cost has been the main consideration.

Single-stage machines compressing to 90 or 100 pounds have been purchased with simple steam cylinders, operating at 125 pounds steam pressure at the throttle. These have operated for years in localities where the fuel cost is high, and where difficulties were encountered, due to dust and carbonizing effects, with consequent losses in economy and explosions due to extremely high temperature conditions and troubles in lubrication.

Improvements have taken place more readily in the air end by the adoption of the two-stage compressors, with consequent economy, due to intercooling, and ease of lubrication because of lower temperature. In the steam end, however, the most economical arrangement of cylinders and valves has not been followed generally, and there has been considerable loss in fuel economy and through investment for increased boiler plant.

Among steam-driven compressors which have been used to a large extent may be mentioned those employing the Meyer valve on the steam end. This type of valve is customarily used in conjunction with a throttling governor, controlled by air pressure. As the valves are hand set, under varying condition of load without constant attendance it becomes necessary to arrange the valves to cut off at a fixed point, necessarily so late as to practically eliminate all the economies which might be expected if the compressor were driven under fixed conditions and constant output. If the Meyer valves are set at an economical cutoff, and a heavy load comes upon the machine, it will stop, and the air supply may be cut off at considerable inconvenience. This type of valve, if the attendant is not on hand to start it, therefore, involves, under varying compressed-air demands, either a loss in economy or constant attendance. The well known throttling type of governor, which is the usual adjunct to this type of compressor, does not permit the highest steam economy.

It therefore becomes necessary, even where the fuel-supply cost per unit is low, if the most economical commercial results are to be obtained to consider carefully not only the design of the compressor in detail, but also the factors entering into the cost of the compressed air plant. In the cost of a new plant this would involve comparison of the cost of the necessary boiler capacity installed, the cost of the compressor foundations, building and all other factors involved in the complete installation. The annual charges, based upon the total cost of the compressor installed for the same capacity of output, added to the cost of fuel, operation and maintenance costs, will give the proper basis for comparison and decision in the purchase of the most economical air compressor.

Since an air compressor is to deliver a certain amount of free air, compressed to a certain pressure, it is desirable in securing bids that the steam consumption be obtained, based

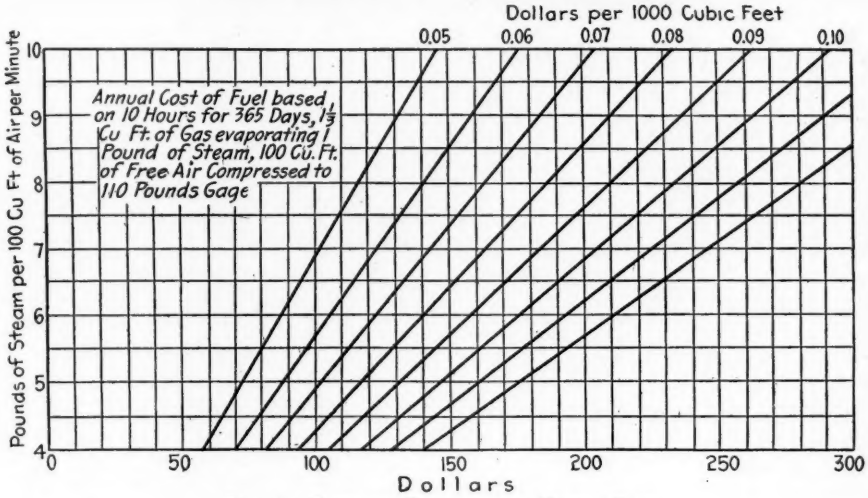

FIG. 1 COST OF FUEL WHEN USING GAS

upon 100 cubic feet of air compressed to the desired gage pressure.

On the accompanying charts are represented the annual fuel cost of compressed air, based on 10 hours for 365 days, when delivering 100 cubic feet of free air compressed to 110 pounds gage. Fig. 1 represents the cost when gas is used for fuel under the steam boilers, and Fig. 2 when using coal. The price of gas is taken as varying from 5 cents to 12 cents a thousand cubic feet, and the price of coal from 70 cents a ton to $1.50 per ton. As a sample of what may be expected from a compressor of approximately 1200 cubic feet capacity, of compound noncondensing steam end with an economical valve gear and two-stage air end, it might be stated that the steam consumption per 100 cubic feet, compressed to 110 pounds gage, is approximately 6.4 pounds of steam.—*Power.*

COMPRESSED AIR ON THE PANAMA CANAL

The principal air compressor plants on the Panama Canal are at Los Cascadas, Empire, Rio Grande and Balboa. These furnish air to the Central and Pacific divisions, and along the high line around Gold Hill on the relocation of the Panama Railroad. For the year ending June 30, 1911, the total output of these plants aggregated 8,261,199,541 cubic feet of free air, at a cost of 0.0324 cents per 1,000 cubic feet.

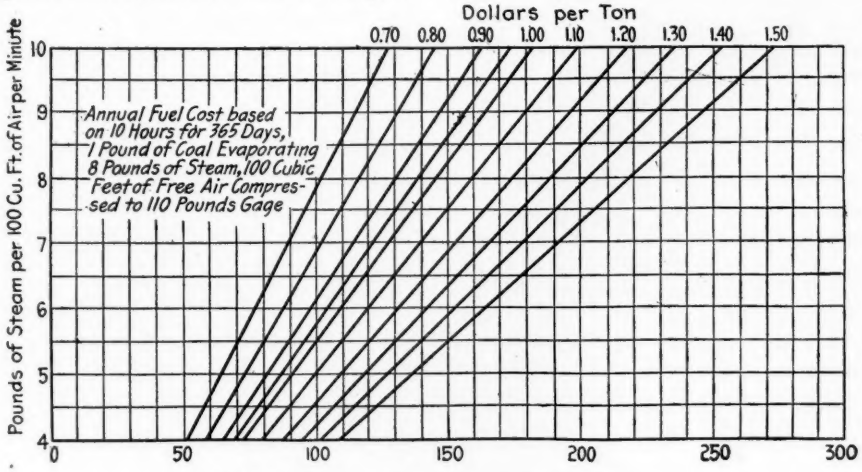

FIG. 2. COST OF FUEL WHEN USING COAL

DRAFT AND DIFFERENTIAL GAGES

By Julian C. Smallwood.*

A cubic inch of water at 60 degrees Fahrenheit weighs about 0.036 pound; hence, a column of water 1 inch high and 1 square inch in cross-section will exert a pressure by its weight of 0.036 pound distributed over the square inch of its bottom surface of contact. If the column is made 2 inches high, this pressure is doubled, and so on.

Mercury, at 60 degrees Fahrenheit, weighs nearly 13.6 times as much as water; therefore each inch of mercury exerts a pressure of

$13.6 \times 0.036 = 0.49$ *pound per square inch*

The simplest form of draft gage, the U-tube, is that shown in Fig. 1. This is a piece of glass tube bent in the form of a U and partly filled with water. It is connected to the flue at *A* by a rubber tube, and when the two water levels are the same the pressure in the flue is the same as that without. But if the level on the flue side of the U-tube is H inches higher than the other, then the pressure of the atmosphere on the open side of the tube is enough greater than the flue pressure to raise the weight of *H* inches of water against it. From this difference in level the difference in pressure is obtained between that in the flue and atmospheric pressure expressed in inches of water.

Such an instrument is easily made and can be put together at small cost. It is not always easy to bend the glass into the form of a U, in which case two straight pieces of glass may be joined by a piece of rubber tubing, as shown in Fig. 2. These may be mounted on a board to which a paper scale is glued and afterward varnished.

The simple U-tube is applicable also to pressures greater as well as less than atmospheric, the high level then being on the open side. For measuring pressures of more than one pound, however, the water gage becomes inconveniently long. Hence, for this purpose a heavier liquid, such as mercury, which will not rise so high, is used. Each inch of mercury being equivalent to 0.49 pound per square inch, indicates a pressure 13.6 times as great as that shown by water.

The scales of these gages are graduated in various ways. Some have an ordinary scale, as in Fig. 2, which requires the height of both levels to be read and then the lower subtracted from the upper to obtain the difference in level. Others are graduated as shown by Fig. 3, the purpose being to avoid two readings. A U-tube supplied with this scale must be filled until the level on both sides is at the zero graduation. Either the upper or the lower scale is read and the reading is doubled to obtain the inches of water. If any of the water is evaporated or otherwise accidentally lost, however, the reading will be inaccurate.

Another form of scale is shown by Fig. 4, which obviates doubling the reading. This may be made adjustable through a small range so that its zero may be readily brought to coincide with the no-pressure position of the water level.

A gage giving direct readings may be made as shown in Fig. 5. This consists of a cup *C* of comporatively large diameter, containing liquid in which a glass tube of small bore is placed. As the liquid rises in the tube the level in the cup sinks, but on account of the large area of the liquid in the cup its level does not sink appreciably. Thus, if the cup is 2 inches in diameter and the tube 1-8 inch bore, for each inch the level in the tube rises that in the cup falls 1-256 inch. If the gage range is 5 inches, the total fall of level in the cup is about 1-50 inch, which in this case is negligible. If the cup is a closed chamber except for a tube leading into its air space, the instrument may be used as a differential gage.

It is on the principle of this gage that the mercury barometer is made, the form of the instrument being like Fig. 5 except that the glass tube is closed at the top and air excluded, as in Fig. 6. This is an absolute-pressure gage as distinguished from a differential gage, the absolute pressure of the atmosphere being recorded by the hight of the mercury column, as there is no other force in the tube than that due to the weight of mercury. A thumbscrew *D* is arranged to adjust the level in the open vessel at a fixed hight shown by the point *E*.

The simple U-tube may be used to show the difference of pressure in two parts of a closed pipe by connecting its two sides, one to each part, as shown by Fig. 7, instead of leaving one side open to the atmosphere. When measuring forced draft it should be connected in this way, one side to the ashpit, the other

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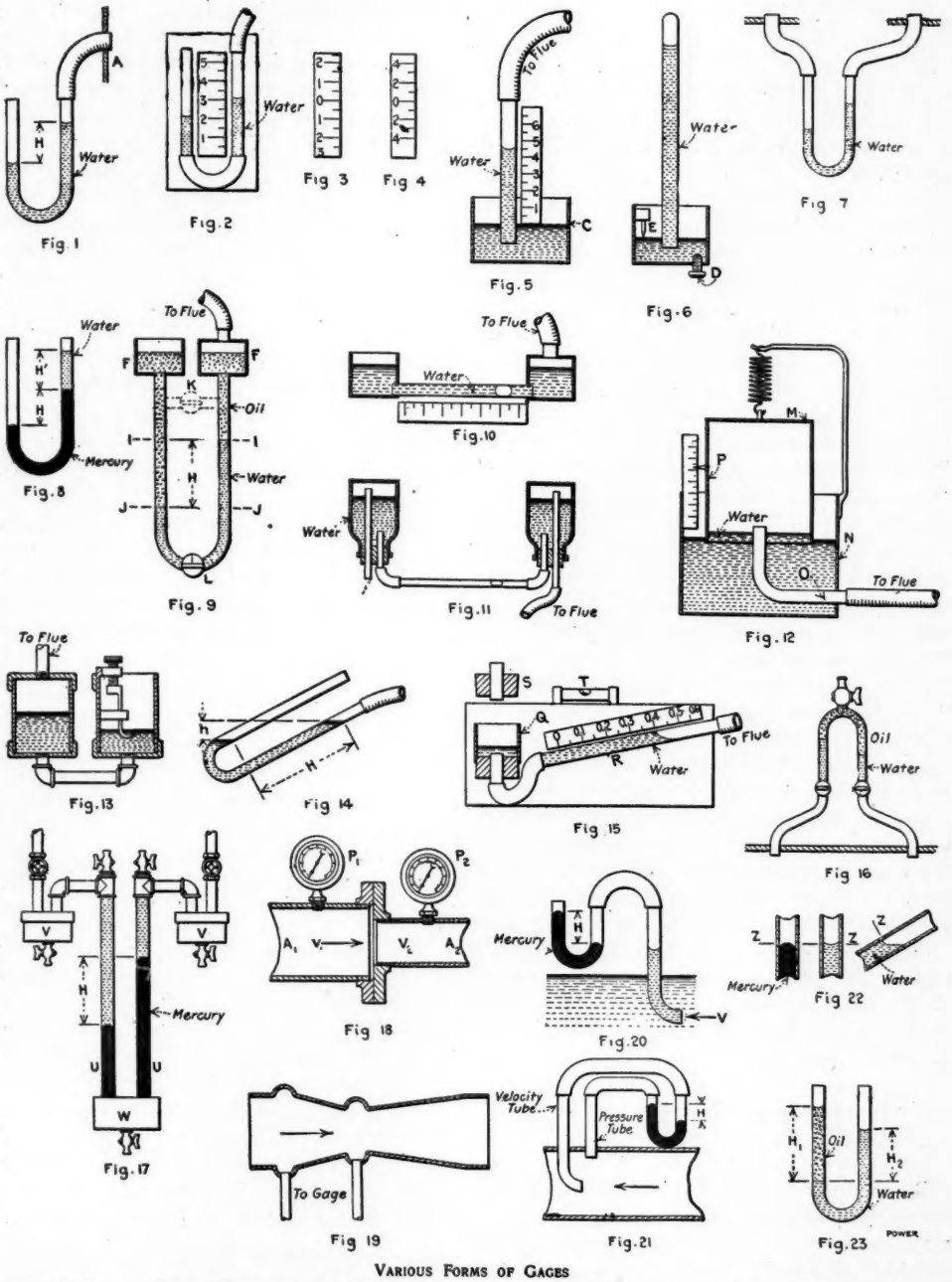
*Associate Professor of Experimental Engineering, Syracuse University.



VARIOUS FORMS OF GAGES

to the chimney flue. The pressure in the ash-pit is greater than that of the atmosphere; that above the fuel bed may be less.

In some appliances for measuring the flow of steam the U-tube may be used, its form being somewhat different for practical purposes. When mercury is employed water of condensation settles on one side of the mercury column and influences the reading. This may be corrected as follows: Considering Fig. 8, the true difference of pressure is

$$H + \frac{H'}{13.6}$$

inches of mercury; that is, the water column in inches is divided by 13.6 to obtain the additional pressure in inches of mercury. If the water were on the other side it would be subtracted.

As applied to furnace drafts, the U-tube as described is not satisfactory because ordinarily, with natural draft, the difference does not exceed a few tenths of an inch. Therefore the instrument is difficult to read closely and does not indicate small changes of draft. To overcome this difficulty a great many ingenious devices have been constructed.

It would appear at first that the difficulty could be overcome by employing a liquor lighter than water. It is not practicable, however, to obtain one enough lighter to magnify the difference of level sufficiently, but two liquids, differing from each other in density, will answer the purpose. Thus in Fig. 9 assume the upper liquid to be oil whose specific gravity is 0.9 and the lower liquid water. If the levels in the cups *F F* are the same, then there is a difference of pressure corresponding to the difference in the weights of the column *H* of oil and water. Above *I I* the columns of oil, being of equal hight, balance each other, below *J J* the water columns also balance. Between *I I* and *J J* there is a column of water acting against the flue pressure and one of oil, equal in hight, acting with the flue pressure. As the pressure of the oil is 0.9 that of the same hight of water the draft is equal to (*H*—0.9 *H*) or 0.1 *H* inch of water; that is, the draft in inches of water is one-tenth of the reading. In general, calling the specific gravity of the oil *S* and *h* the draft in inches of water,

$$h = (1 - S)\ H$$

If the heavier liquid is not water and has a specific gravity S_1, then

$$h = (S_1 - S)\ H$$

By choosing the liquids for such a gage of nearly the same densities, any desired range may be obtained for the measurement of a small difference of pressure. The more nearly equal in weight they are the greater the motion of the liquid for a given draft. In general, the number of inches of rise in the ordinary U-tube is multiplied by $\frac{1}{S_1 - S}$

In practice, when used as a draft gage, the difference of level in the cups *FF* would alter the foregoing relation. To keep the cup levels the same a cross-connection with a cock *K* *joins* the tops of the tubes. Another cock *L* is placed at the bottom of the tubes. When in use *K* is closed first and *L* opened; when the oil stops rising in the right-hand tube, *L* is shut and *K* opened and the flue connection is removed. This allows the oil in the cups to come to the same level again without disturbing the levels in the tubes. The cocks are then reversed until the oil has risen again as high as it will, and the level in the cups is adjusted once more. This is repeated until the oil no longer rises, upon which the reading is taken.

The draft gage shown in Fig. 10 consists of two cups, one closed, the other open to the atmosphere. They are connected below the water line by a horizontal tube of small bore containing water in which there is a small air bubble. The motion of this bubble is a measure of the draft. As the water rises in the right-hand cup the bubble moves to the right a distance proportional to the difference of level in the cups. By making the ratio of cross-sectional areas of the cup and the tube bore the required amount, any desired range of motion may be obtained, the motion being inversely proportional to the ratio of areas.

Fig. 11 shows how this form of gage may be easily made from two bottles with perforated corks together with glass and rubber tubing.

A draft gage designed by Professor Kent is shown by Fig. 12. It is made of two tin vessels *M* and *N*, the former inverted and suspended within the other by a spring. Its interior is subjected to flue pressure through the tube *O*. The pressure of the atmosphere being greater tends to push down the suspended can. This tendency is opposed by the spring and, according to its extension recorded by the pointer P, the draft is measured. The equation of the instrument, neglecting buoyancy, is

$$p \times a = 0.036\ h \times a = n \times H$$

from which,

$$h = \frac{n \times H}{0.036 \times a} = k \times H$$

where,

p = Difference between fuel and atmospheric pressures in pounds per square inch;

a = Internal cross-section, in square inches, of can M;

n = Number of pounds corresponding to 1 inch extension of spring;

H = Extension of spring in inches corresponding to $p \times a$ pounds;

h = Draft in inches of water;

$$k = \frac{n}{0.036a}$$

The equation ($h = k\ H$) shows that to obtain the draft the reading on the scale is multiplied by a constant which is less than one. The increasing buoyancy as M sinks is negligible if the design of the gage is good. This instrument does not quickly respond to changes of draft, however, and is cumbersome.

Fig. 13. Shows Miller's draft gage in which the difference of level is not magnified, but a very precise instrument, the hook gage attached to a micrometer, is used to measure the level.

Perhaps the simplest and most satisfatcory form of draft gage is the variation of the ordinary U-tube shown by Fig. 14. It is set on a slant so that a vertical difference of h inches between the water levels causes an actual motion of H inches. By varying the slant any desired magnification may be obtained. This is generally made with a scale on the principle illustrated in Fig. 4 so that only one reading need be taken. It may be readily constructed of a piece of gage glass Q (Fig. 15) and a glass tube R together with some rubber tubing; perforated corks S may be used if forced draft is to be measured. The gage should be mounted on a board to which a spirit level T is attached so that the slant of R may be kept as intended.

For the purpose of making this gage more compact the slanting tube is sometimes in the form of a helix.

Most of the previously described gages are applicable to the measurement of water as well as gas pressure, the liquid used in them for this purpose being mercury or oil. Fig. 16, for example, shows the ordinary U-tube inverted for use with oil.

Fig. 17 shows a gage using mercury for large differences of pressure. One-eighth-inch pipe and fittings are used and the long gage glasses U U are joined by a cast-iron well W. The pots V V are arranged to catch the mercury should the pressure become sufficiently great to blow it beyond the gage glasses. The cocks are arranged for introducing the mercury and excluding the air. In the right-hand column there is acting a weight of H inches of mercury which is partly balanced by the same height of water on the other side. The mercury column causes a pressure of 13.6 H inches of water; therefore the pressure difference indicated by the gage is

$$13.6\ H - H = 12.6\ H \textit{ inches of water}$$

or 1.05 H feet. That is, to interpret the reading of this gage its reading in inches must be multiplied by 1.05 to get the difference of pressure head in feet.

APPLICATIONS OF THE DIFFERENTIAL GAGE.

In Fig. 18 the symbols P, V and A stand for pressure head in feet, velocity and area in square feet respectively at the two sections of the pipe. Since the sections at A_1 and A_2 are different, the velocities will be different, V_2 being as many times V_1 as A_1 is times A_2. Neglecting the losses due to friction, etc., the total energy of the water in the one section is equal to that in the other, this energy being in two forms, pressure and velocity. Since the velocity in the small pipe is greater than that in the large, the pressure in the latter must be less and the diminution in pressure energy must equal the gain in kinetic energy. Therefore, the difference of pressure in the two pipes is a measure of the velocity and consequently the quantity, according to the following relation:

$$Q = \frac{A_1 \times A_2}{\sqrt{A_1^2 - A_2^2}} \sqrt{2\ g\ (P_1 - P_2)}$$

in which Q is the quantity flowing in cubic feet per second and g is the acceleration due to gravity, 32.16. This is the principle of the venturi meter, a very precise instrument for the measurement of the flow of water. It has also been applied to steam and perfect gases but with less success. Fig. 19 shows the usual proportions of the meter, the actual discharge being between 95 and 99 per cent. of that shown by the formula.

Fig. 20 reprsents a Pitot tube, another instrument for measuring velocities and quantities. It is a tube having a quarter bend, set facing the direction of flow. The hight H of the liquid in the tube is a measure of the velocity or

$$V = \sqrt{2\,g\,h}$$

h being the head in feet of whatever liquid or gas is flowing. To convert the reading H to the equivalent head of the fluid whose velocity is being measured, it is necessary to multiply by the ratio of the densities of the gaging and the measured fluids. Thus, if the gaging liquid were 10 times as heavy as the fluid being measured, h would equal 10 H. In general,

$$V = \sqrt{2\,g\,C\,H}$$

in which C is the ratio of densities.

The Pitot tube has been used largely for velocity measurements in open streams, but not until comparatively recent years has it been applied extensively to the flow of liquids and gases in closed pipes. Fig. 21 shows its arrangement for this purpose. Since in such a system pressure is recorded as well as velocity, a pressure tube is added. Static pressure only acts through this tube and balances the static pressure in the other tube; hence the gaging liquid records the velocity head only.

The simplicity of this device is alluring, but it should be used with caution in careful measurements as a great many possible conditions may cause inaccuracies. The velocity of the fluid varies across the pipe section and the velocity tube must be placed at the point of mean velocity. The fluid sweeping past the pressure tube tends to make a suction reducing the effective pressure in it. If there are eddies in the current these also tend to distort the record. The gaging generally should be made in a clear, straight stretch of pipe where there is nothing to disturb the uniform passage of the fluid.

When used for the flow of water with mercury as the gaging fluid

$$V = 8.23\,\sqrt{H}$$

and for the flow of air at atmospheric pressure and 60 degrees Fahrenheit, water being the gaging fluid,

$$V = 66.3\,\sqrt{H}$$

in which V is the velocity in feet per second and H the reading in inches.

The gages described are useful in measuring losses of pressure in various parts of blower systems. By their use leaks may often be located and otherwise unsuspected losses remedied.

PRACTICAL HINTS.

The level of mercury in a glass tube curves from the center downward, while that of water curves upward. It is best to read the hight on a horizontal line tangent to the curve, as Z Z, Fig. 22. In the inclined-tube form of gage, if the tube is about ⅛ inch in diameter, the level takes a curve as shown, which is very conveniently read at Z. The bore of the tube used should not be too small as capillary action may cause error.

When oil is used as a gaging fluid its specific gravity may be found as shown by Fig. 23. A little oil is floated on water in one side of a U-tube and its hight H_1 and that of the column of water balancing it H_2 are measured. Then the specific gravity of the oil is $\frac{H_2}{H_1}$

Considering the units of pressure measurement dealt with, it is unfortunate and illogical that three different physical quantities and two starting points for measuring are employed when one would do. There is no reason why the ordinary spring-pressure gage should not be graduated in pounds above a perfect vacuum and its units used for whatever pressures are measured. U-tube scales, no matter what their liquid, could be graduated to read directly in pounds per square inch quite as conveniently as the present system of inches. It may be contended that for drafts and small pressure differences the pound is too large a unit. This could be remedied by using one one-hundredth of a pound as the unit for small pressures. There would then be 3.6 of these units to an inch of water. Condensed from *Power*.

The only gas produced from crude oil up to within a very recent period, has been one having a value from 550 to 680 B. t. u. per cubic foot, used for domestic lighting and cooking. This gas has been produced by the process known as the 'cracking' of the crude oils, which is largely disruptive in effect and frees a very large percentage of hydrogen and carbon, resulting in a gas carrying 50 per cent. and upward of free hydrogen. This gas will give no higher efficiency in a gas engine than distillate.

TESTS OF SAND BLASTING MACHINE

This paper gives the records, results and conclusions of a series of quantitative tests of a sand-blasting machine, under the actual conditions of commercial practice, which were made by David H. Ebinger and Robert A. Frevert, of Columbus, under the direction of the author as their thesis for the degree of mechanical engineer from The Ohio State University in 1910.

The conditions of this set of tests were as follows:

The material was pieces of cast-iron which had been broken as test bars for transverse tests. They were 2 in. by 4 in. in cross-section and from 15 to 25 in. long. They had been cast diagonally on edge in one mold from one ladle of machinery iron. Their rough surfaces were as uniform as were the bars themselves. A new nozzle, 5-16 in. in diameter, was used for each test. To remove any unevenness of the interior surface of the nozzle, and to bring them all exactly to the same condition, sand was blown through each for 2 minutes previous to starting the tests. The sand used was a No. 3-J Cape May grit, new, hard, sharp, clean, free from clay, and was such as is commonly used by the trade. It was thoroughly dried in a Pangborn No. 1, Type M, sand dryer. The sand was then passed through No. 8 mesh screen. After use in the machine, it was weighed, sifted, reweighed, and discarded. The compressed air was passed through a separator to relieve it of moisture from the atmosphere and oil from the compressor.

No attempt was made to regulate and adjust the proportion of air to sand. All tests were run with the regulating valve wide open. Upon the three remaining variables, the air pressure, the angle between the surface of the work and the nozzle, and its distance from the work, the quantitative experiments were made. The regular equipment of the D. A. Ebinger Sanitary Manufacturing Company at Columbus, Ohio, was used for these tests. It consisted of one sand blasting machine with a sand capacity of 4,000 lb. per charge. It was

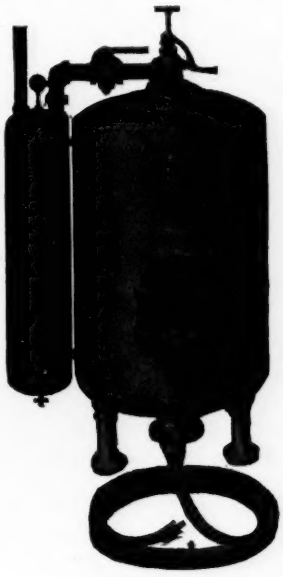


FIG. 1.

provided with a moisture separator, pneumatic sand separator, dust catcher and exhaust fan.

Fig. 1 shows the machine and Fig. 2 the regulating and controlling valves. Fig. 3 shows the mixing chamber for the air and sand. Fig. 4 shows a plan of the rooms and apparatus. Fig. 5 shows the sand-blasting box and sand-catcher. Fig 6 shows a photograph of the machine, blasting room and apparatus. Figs. 7 to 9 graphically show the results obtained.

OPERATION OF THE MACHINE.

The compressed air enters the moisture and oil separator at the left of the machine, passes through the air regulator *a*, which has an indicator-handle working over a graduated disc, enters and passes down through the cylinder *b*, inside the machine, then through the air ports in the piston *c*, and engages the entering sand. The ports in the top of the cylinder, one of which is shown, deliver the air to the sand chamber, so as to maintain equal pressure above the sand and to assist in insuring uniform flow. The sand-controller handle, *d*, moves on a quadrant, having limit stops for its off and on full positions. This handle permits the piston *c* to be rotated in its casing *e*, thereby opening, regulating and closing the sand ports by a single control. The stirrer and handle *f* connect with its fork which operates inside of the piston and mixing cham-

*Abstract of a paper presented at the New York meeting (Dec. 1911) of the American Society of Mechanical Engineers by Prof Wm. T. Magruder, Ohio State University, Columbus, Ohio.

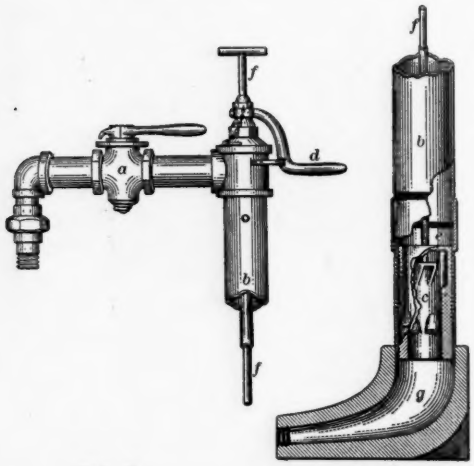


FIG. 2. FIG. 3.

ber for dislodging caked sand that may form under certain conditions. Ports, elliptical in shape, are located in opposite sides of both the piston *c* and the casing *e*, and are inclined downwards, so starting the flow of the sand by gravity. The rotation of the piston by the controller handle regulates the opening of the ports and the flow of sand. The sand on leaving the ports is met by the air coming through the ports in the piston. They cross each other from opposite sides into the mixing chamber *g*. By this cross flow, a swirling motion is produced and a thorough mixture of the sand and air is obtained in the rear part of the mixing chamber. The mixture is carried forward by the air pressure from the rear part, 2½ in. in diameter, to the hose connection where it is ¾ in. in diameter, thence through the hose to the nozzle, whence it is projected upon the casting to be sand-blasted.

The air used was measured by a pitometer placed horizontally in a run of straight 1½ in. standard welded pipe in the main air line, and located at a distance from any fitting. The opening, 1-8 in. in diameter, of the dynamic tube faced the current of air from the receiver tank. The end of the static tube was trimmed off flush with the interior of the pipe. The tubes were connected by 1-8-in. pipes to the ends of a water manometer. The difference in the levels of the liquid in the two legs of the manometer indicated the difference between the dynamic and static pressures, and is a measure of the velocity head in inches of water. From the formula, $v^2 = 2\,gh$, the velocity of the air in the pipe was calculated. Deducting the area of the dynamic tip from the area of the opening in the pipe, gave the net area of the air pipe. The coefficient of discharge was taken as 0.91. To remove the moisture that collected in the tubes, valves were placed in each of the tubes above the manometer, and pet cocks placed in the tubes directly above the valves. This arrangement permitted the blowing out of each tube before taking a reading of the pitotmeter. The temperature of the air in the line was taken just before it entered the stop valve at the machine. Calibrated pressure gages in the line and at the machine gave the desired pressures.

To collect the sand used during each test and also to control the blast, a closed box with a hopper bottom and a shelf at one end to support the test bar was prepared, as is shown in Fig. 5. The sand discharged during a test was collected in the hopper, removed, and weighed as total sand used. It was then sifted, and again weighed, thus giving by difference the amount of sand rendered useless

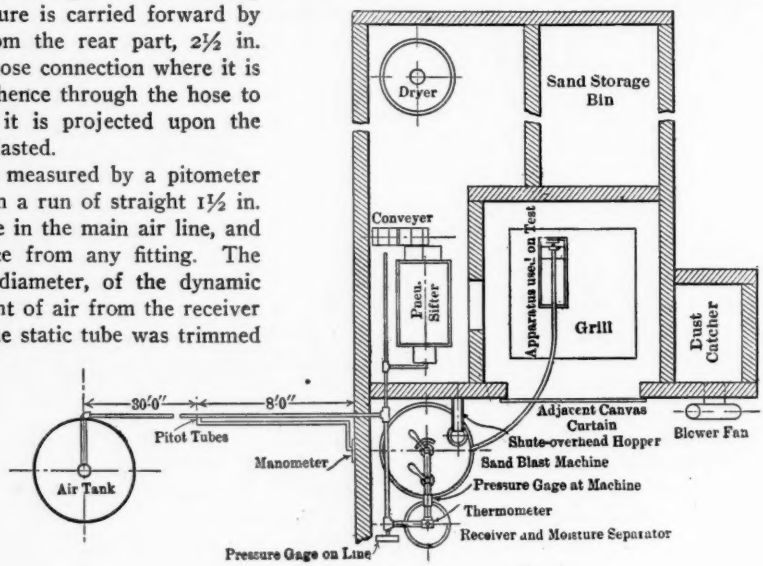


FIG. 4.

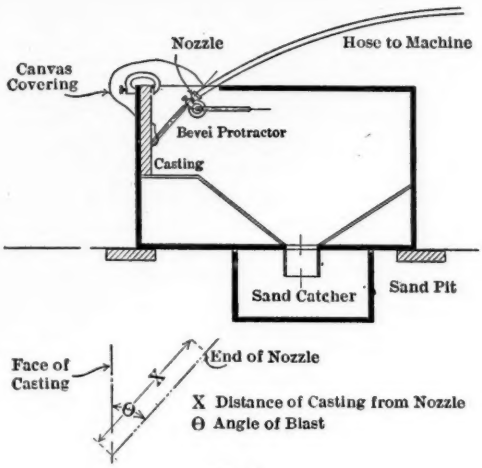


FIG. 5.

by the test, and the amount of sand that might be used again in commercial practice.

The test bar was held in a vertical position in the sand-blasting box. Before and after blasting it was weighed to quarter ounces.

In each test the new nozzle was first brought to a uniform condition by discharging a blast of sand and air through it for 2 minutes under a constant blast pressure. The test bar was weighed and placed in position in the closed hopper box. The nozzle was then set for its distance from the test bar and for its angle with the surface of the test bar. The air regulator *a* was kept wide open during the tests. The desired air pressure in the machine was secured and maintained constant by adjusting the stop valve in the supply pipe to the moisture separator. After starting the air blast and adjusting the valve to maintain a constant pressure at the machine, the sand-controller handle *d* was moved to its open position at the instant of starting, thus allowing sand to flow into the mixing chamber and to be forced by the blast of air out through the nozzle and against the test piece. Readings of the temperatures and pressures of the air on the main line and at the machine were taken at regular intervals of about 2 minutes. In closing down the machine at the end of a test, the sand valve was first closed and then the air valve; the test bar was weighed, and the difference of the two weights gave the amount of iron removed.

Starting at 20 lb. corrected pressure at the machine on the first test, and increasing by 10 lb. up to and including 70 lb. pressure, the to increase of pressure was obtained, with the nozzle set at 45 deg. and at 8 in. from the test bar.

In the second series of tests, a constant pressure of 60 lb. was maintained at the machine, and the nozzle set at 8 in. from the test bar. The angle was varied from 30 to 90 deg. The effectiveness of these angles of blast was in this way obtained.

In the third series of tests, the distance of the nozzle from the test piece was varied, the angle being set at 45 deg. and the air pressure maintained constant at 60 lb.

It was noted that with no sand flowing, the quantity of air flowing approximated the theoretical discharge for the nozzle. On turning on the sand, the quantity of air flowing immediately decreased; and when the sand was "on full," the amount of air discharged was only 40 to 50 per cent. of the original quantity.

With constant air pressure and with the sand-controller lever in its "on full" position,

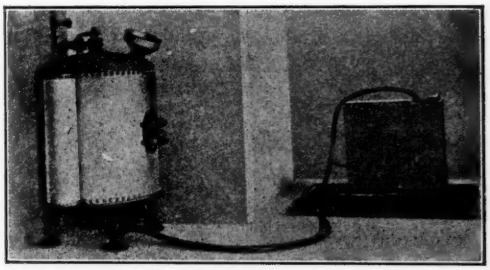


FIG. 6.

on account of the variation in the openings of the sand and air ports of the machine, about 30 tests were required to be made in order to get even fairly concordant results for the pounds of sand discharged per 100 cu. ft. of free air flowing per minute, as shown on Line 27, Fig. 7. For constant pressure, variations in the pitotmeter readings were due to the variations in the sand flowing. As the quantity of sand decreased, the velocity and quantity of air increased, but the quantity of sand discharged per pound of iron removed also decreased. It would seem that further experiments might prove that at other angles than 30 deg., and at other distances than 8 in., and at other pressures than 60 lb., less sand would be used per pound of iron removed if the sand-variation in the effectiveness of the blast due

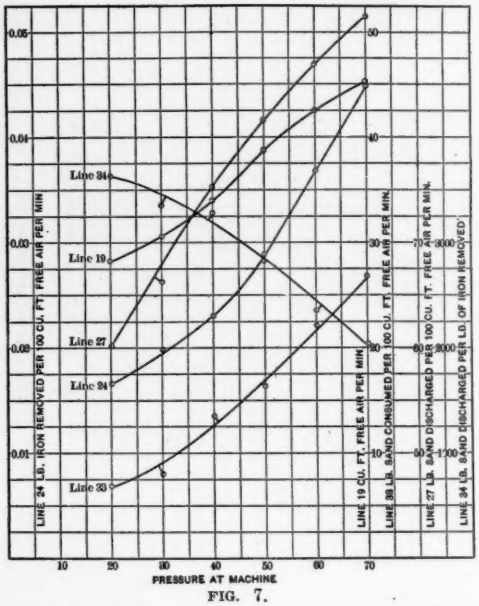

Line 34
Line 19
Line 27
Line 24
Line 33
LINE 24 LB. IRON REMOVED PER 100 CU. FT. FREE AIR PER MIN.
LINE 19 CU. FT. FREE AIR PER MIN.
LINE 30 LB. SAND CONSUMED PER 100 CU. FT. FREE AIR PER MIN.
LINE 27 LB. SAND DISCHARGED PER 100 CU. FT. FREE AIR PER MIN.
LINE 34 LB. SAND DISCHARGED PER LB. OF IRON REMOVED
PRESSURE AT MACHINE

FIG. 7.

regulating valve was not open so much. This would make the energy of the individual grain of sand greater and its blasting effect larger. Furthermore, there would be less piling up of the sand on the surface being sand-blasted.

From these quantitative experiments on a

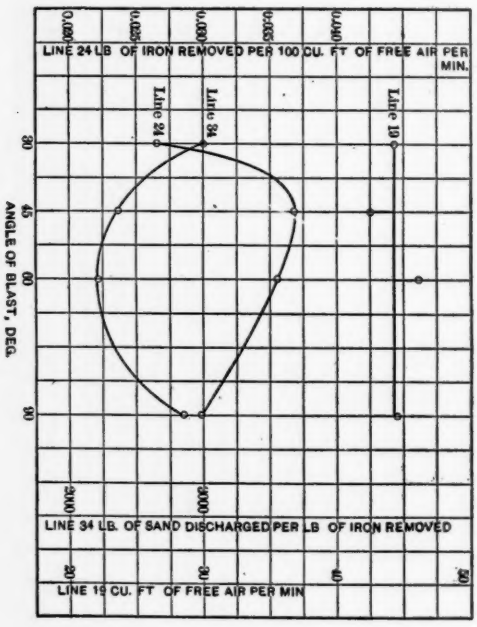

LINE 24 LB. OF IRON REMOVED PER 100 CU. FT. OF FREE AIR PER MIN.
Line 24
Line 34
Line 19
ANGLE OF BLAST, DEG.
LINE 34 LB. OF SAND DISCHARGED PER LB. OF IRON REMOVED
LINE 19 CU. FT. OF FREE AIR PER MIN.

FIG. 8.

cast-iron test bar for these three variables, within the limits used, the results as graphically shown in Figs. 7, 8 and 9, are as follows:

For a constant distance of 8 in., and at a constant angle of 45 deg., between the nozzle and the test bar, the equivalent amount of free aid delivered per minute, the iron removed, the sand discharged, and the sand used up per 100 cu. ft. of free air flowing per minute, vary directly with the pressure; the per cent. of usable sand remaining, and the amount of sand discharged per lb. of iron removed vary inversely with the air pressure in the machine. (See Lines 19, 24, 27, 33, 30, and 34, Fig. 7).

With a constant pressure of 60 lb. in the

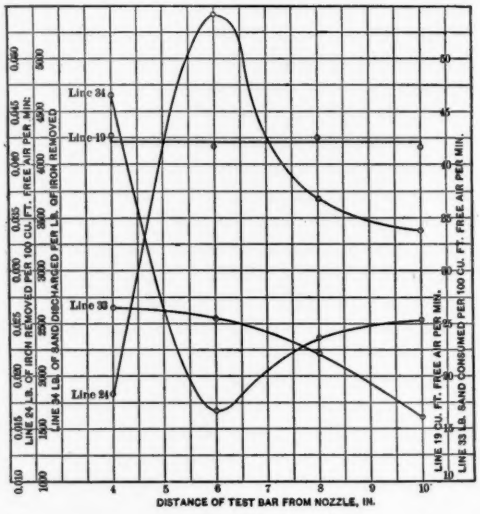

Line 34
Line 19
Line 39
Line 24
LINE 24 LB. OF IRON REMOVED PER 100 CU. FT. FREE AIR PER MIN.
LINE 34 LB. OF SAND DISCHARGED PER LB. OF IRON REMOVED
LINE 19 CU. FT. FREE AIR PER MIN.
LINE 33 LB. SAND CONSUMED PER 100 CU. FT. FREE AIR PER MIN.
DISTANCE OF TEST BAR FROM NOZZLE, IN.

FIG. 9.

machine, and a fixed distance of 8 in. from the nozzle to the test bar, the largest amount of metal was removed, and the least amount of sand was required to do it, when the angle between the nozzle and the surface of the work was from 40 to 60 deg. (See Lines 24 and 34, Fig. 8).

With a constant pressure of 60 lb. in the machine and a constant angle of 45 deg. between the nozzle and the surface of the test bar, the largest amount of metal was removed, and the least amount of sand was required to do it, when the distance from the nozzle to the work was about 6 in. (See Lines 24 and 34, Fig. 9).

With a constant pressure of 60 lb. and a fixed distance of 8 in. from the nozzle to the

test bar, the amount of sand used up varies as the directness of the blast.

With a constant pressure of 60 lb., and a constant angle of 45 deg. between the nozzle and the test bar, the amount of sand used up varies inversely with the distance of the nozzle from the test bar. (See Line 33, Fig. 9).

For a constant angle of 45 deg., and a fixed distance of 8 in. between the nozzle and the test bar, twice as much metal was removed at 56 lb. pressure as at 20 lb.; at 64 lb. as at 30 lb.; and at 72 lb. pressure as at 40 lb. (See Line 24, Fig. 7).

With a constant pressure of 60 lb., and a constant distance of 8 in. between the nozzle and the test bar, over 20 per cent. more metal was removed with the nozzle held at 45 deg. than at 90 deg. to the test bar.

With a constant pressure of 60 lb., and a constant angle of 45 deg. between the nozzle and the test bar, 60 per cent. more metal was removed when the nozzle was held at 6 in. than at 10 in. from the test bar.

Unless it can be shown that the extra cost of compressing 100 cu. ft. of free air per hour to a pressure of 70 or 80 lb. per sq. in. exceeds the cost to compress it to 30 or 40 lb. by the cost of an hour of labor (25 cents), the higher pressures, delivered at an angle of about 45 deg., and at a distance of about 6 in. from the work, are to be preferred for the sand-blasting of cast iron.

RECORD RAINFALL

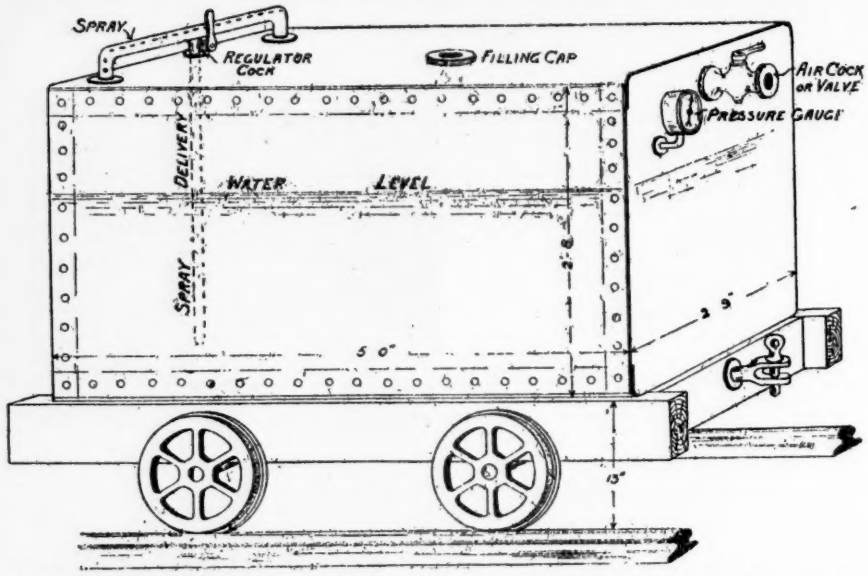
Lord Macauley has said somewhere that one who has never lived in the tropics knows nothing about rainfall. The greatest concentrated rainfall on record is reported at Manila, P. I., as having occurred in Western Luzon last July and August. There were three typhoons in that district between July 11 and Aug. 2, 1911, the heaviest of which raged from July 11 to 17. During the first three days of that period the total rainfall recorded at Baguio was 88 ins., 32 ins. of which is reported to have fallen during the first 24 hrs. Baguio is the mountain resort in the province of Benguet, at an elevation of several thousand feet. The road leading to it, which was built a few years ago at large expense and difficulty, is said to have suffered great injury from the floods following the storm. Two years ago there was a rainfall in Jamaica, W. I., of 48 ins. in four days, which was then thought to be the heaviest rainfall ever recorded for a limited period.

AN AIR LIFT REVIVES A RIVER

The half tone shows an air lift discharge from a large well turned into a river bed to maintain the flow. It is at San Antonio, Texas, where the river of the same name is in dry seasons little more than a series of stagnant pools extending through the city. More than 1,000,000 gallons per day were pumped during the summer from a 12 inch well in Brackenridge Park and turned into the stream as shown, greatly improving the sanitary conditions.

AIR HOSE FOR SOUNDING AND AS A SHALLOW WATER INDICATOR.

A shallow water alarm for ships has been recently tested out by freight steamers on the Great Lakes. It is not used in deep water, but is serviceable where the depths are not known and danger may be suspected. It consists primarily of a line of ½-inch armored rubber hose 300 feet long trailing under the vessel and through which air is kept flowing or ready to flow from an air receiver which is kept supplied by an air compressor. When a vessel so equipped is moving through the water at 14 miles an hour the inclination of the hose caused by the speed leaves the end of it 60 ft. below the surface of the water, and at this depth the air pressure is not quite sufficient to drive out the water and cause the air to escape. When, however, the end of the hose trails on the bottom at a depth of less than 60 feet the air begins to escape, a gage on the pipe showing the pressure at which the air escapes, from which the depth may readily be computed.



AN AUTOMATIC SPRAYING TUB

The cut, from Iron and Coal Trades Review, is an English contribution to the solution of the problem of spraying the roadways in coal mines. The "tub" is a rectangular tank of 3-8 in. steel plates riveted with 2½ by 2½ by 3-8 in. angles. The underframes are of oak, the centre bar, chain, and axles being of mild steel. The wheels are of cast steel, 14 in. in diameter. A vertical pipe extends from near the bottom of the tank up through the top at or about the position shown. A horizontal pipe, with downward curved ends, is fitted to the top of the vertical pipe, and extends the full breadth of the tank, a stop cock or valve being provided on the vertical pipe just below the junction. On the upper surface of the horizontal pipe there is a series of holes of such a size that water under pressure discharges through them, forming a thin sheet or curtain. The tank is charged about two-thirds full with water, and the space above the water is filled with compressed air, conveyed through the air cock shown from a compressed air supply, or if the supply is not available, the tank can be charged by means of a suitable pump. A connection is provided on the tank for coupling a hose pipe, provided with a spray nozzle on the end, to enable parts of the mine to be reached to which the tub cannot penetrate. A safety valve and pressure gauge are also provided. The spray extends to and strikes against the sides and the roof of the roadways. The dust is thereby deposited in a wet state on the bottom of the roadways, and can be removed in the ordinary way. In a recent trial, it is stated, the tub disposed of 150 gallons of water in a period of 45 to 50 minutes. With an initial pressure of 80 lbs. per square inch, reducing down to 5 lbs., it maintained a spray of 20 ft. all around. No mention is made of stay-bolts, but the rectangular shape would seem to demand them.

WILD FLOWERS AND UMDERLYING MINERALS

That certain flowers often indicate the existence of underlying zinc ores is well known to many prospectors. Also in our phosphate desposits in the west, the exceptionally luxuriant verdure usually permits the facile tracing of the phosphate bed where the latter is covered with soil. In Europe, a little violet, which is known to botanists as *Viola calaminaria,* grows in particular abundance in soils containing calamine zinc ores, hence the specific name of the flower. The same violet occurs at the Horn silver mine in Utah, which has zinc blende. In Sardinia there is also a special flower which seems to be restricted in habitat to zinc-bearing soils, and especially to those containing calamine ores; this flower is the *Anagallis collinae,* the bright orange-red buds of which bloom in May.

Section A-A View No.1

FIG. 2

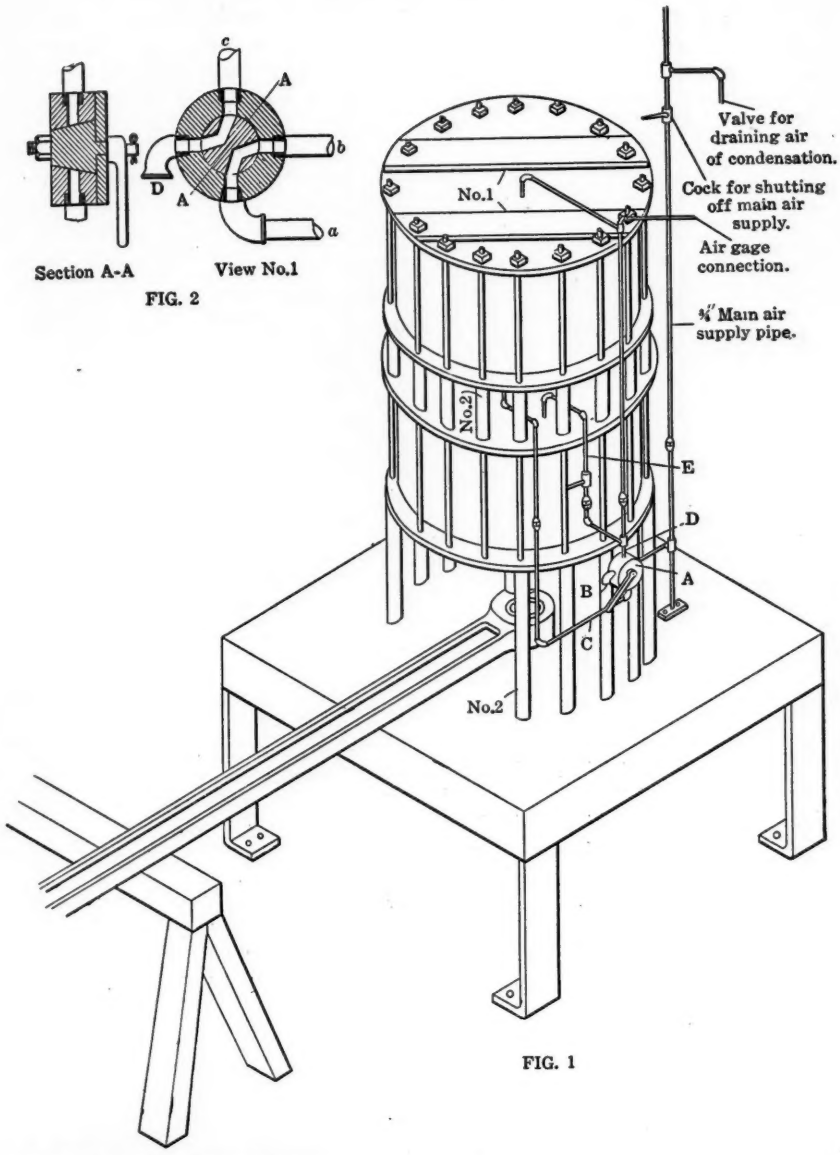


FIG. 1

TANDEM AIRCYL INDERS DOUBLE THE POWER OF A PRESS

A very useful contrivance for the application and removal of rod bushings is shown in the accompanying drawing. It was evolved and is in use at the Winona, Minn., shop of the Chicago and North Western Railway, and is said to be a great time-saver over the method formerly in vogue of doing this work on a wheel press, an improvement in fact amounting to the handling of ten bushings to one.

It will be observed that the press consists of two tandem cylinders. These are 21-in. diameter by 12 in. stroke, and were made from a locomotive cylinder bushing. The heads are of ½-in. boiler steel, reinforced by two 1-in. x 3½-in. pieces of flat iron. The pistons are of ½-in. boiler steel, with a collar riveted in the center which acts as a reinforcement for the piston rod, and 1½-in. angles riveted radially for additional strength. The entire contrivance is held together with sixteen one-inch

bolts, as shown in Fig. 1, part of them running through the work table, and the others only to the bottom head. Pieces of pipe (No. 2) around these bolts act as separators for the cylinders and between the lower cylinder and the table.

The apparatus is controlled by the three-way valve shown at (A), Fig. 1, and in section in Fig. 2. This is made of round stick brass with a taper plug similar to a cutout cock. Holes are drilled in the body and the plug as shown. (a) connects with the top cylinder and under the piston for raising both pistons: (b) with the main supply pipe, and (c) with both cylinders on top of their pistons for pressing in the bushings. When the valve is in the position shown in Fig. 2, the main supply is connected with pipe (c), Fig. 1, and the pistons are raised, while pipe (D) is connected with the exhaust (d), Fig. 2. By placing the handle in mid position the valve is closed; in the extreme position the main supply is connected with pipe (D), Fig. 1, and pipe (c) is in connection with the exhaust.

As an index of the pressure employed a common air gauge, registering to 100 lbs., was made use of by pasting a circle of paper on the dial with the approximate tons marked opposite each ten-pound division, this ratio being easily computed as follows: the area of the two pistons = 692.72 sq. in., divided by 2,000 = .346 tons for one pound pressure, and multiplied by 10, 20, etc., gives the equivalent entirely around the dial.

This press is placed near the end of the rod department in the Winona shop and is served by a one-rail traveling air hoist.—*American Engineer and Railroad Journal.*

THE TYPHOID MYSTERY

A physician I knew well, once had a case of typhoid fever at a farm house, and found that none of the people living in the house had been away for some time previous, and that contagion in this way was therefore impossible. He was absolutely unable to say how typhoid had got into the family. He examined the well, and so far as he could tell, it seemed all right. He happened to hear that nine miles away, there had been a great epidemic of typhoid. In that country, water does not always find its way to the surface of the ground very quickly, and it occurred to him that possibly there might be some connection between his patient's well and that nine miles away. So he got a large package of eosin [reddish coloring matter derived from coal-tar] and poured it into the well nine miles distant. Only two days later the water in the well which his patient used was red. A direct connection in this subterranean passage, by carrying the typhoid germs from that distance, had affected the family nine miles away.—*Dr. Harvey W. Wiley.*

ETHEREAL ASPHYXIA

Ethereal asphyxia, induced by abnormal atmospheric conditions, is what Calbraith P. Rodgers, transcontinental aviator, declares attacked him when he fell near Compton, Cal., on the last flight of his cross-country trip. Furthermore, Rodgers asserts, this is what caused the deaths of dozens of aviators.

"It lurks in the pockets of the upper air strata," he said, "and creeps irresistibly upon the senses of the aviator, lulling him into dreamy unconsciousness.

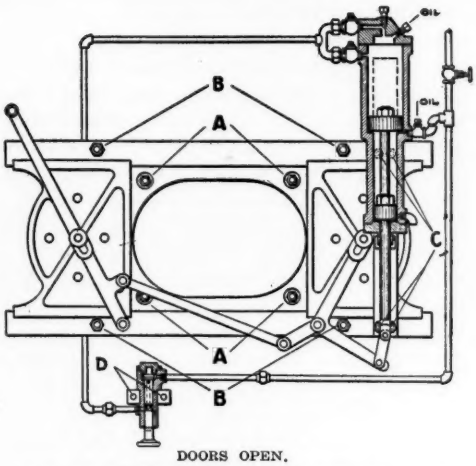
"I believe this same thing to have caused the deaths of Arch Hoxsey, Ralph Johnstone, Eugene Ely and a number of others who have fallen to their deaths from great altitudes, after having lost control of their craft.

"It was not in my case the rarified air that overcame me. I have experienced oxygen-lacking air a dozen times and it never affected me.

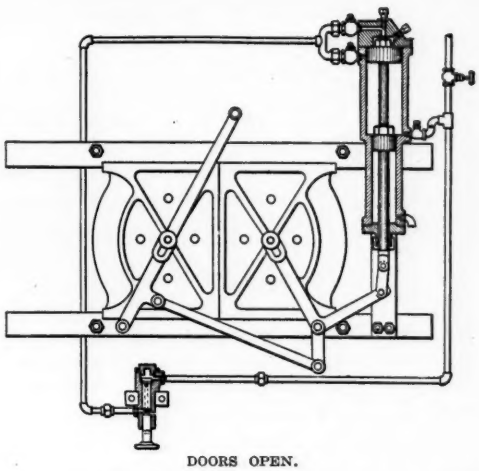
"There was no stifling sensation, but I did notice a peculiar odor, not unlike chloroform. I knew I was falling, but did not lose consciousness until within a few feet of the ground.

"The sense of drowsiness was first apparent shortly after I had passed over a small town south of Pasadena. I was up about 1,500 feet. I tried to shake it off, but it increased. The desire to sleep was irresistible. Then, I thought the machine could take care of itself. There was no pain, no noise in my ears. It was just a sweet, soothing feeling that I wanted to go to sleep.

"Somehow, I got a grip on myself and started on a long glide toward the earth. The nearer the ground I got the sleepier I became. I remember that I had righted my machine and was looking for a place to land when I suddenly lost all consciousness. It was then that I fell."



DOORS OPEN.



DOORS OPEN.

AN AUTOMATIC FIRE DOOR FOR LOCOMOTIVES

The cuts, from Railway Age Gazette, show the latest arrangement of the Shoemaker automatic air operated fire door for locomotives, made by the National Railway Device Company, Chicago. It is claimed that the parts which have heretofore rendered the door inoperative on account of intense heat have been eliminated, and that the air containing parts are sufficiently removed from the door opening to avoid trouble due to the extreme heat. In the Shoemaker air cylinder, the differential idea which has been so successfully embodied in the construction of the locomotive air pump, has been used, and with it the up-stroke of the piston or the door-closing movement is automatic. The doors are locked shut by air in their closed position, which prevents them from working open when the locomotive passes over sharp curves. The piston down-stroke or door-opening movement is secured by applying the air to the upper side of the large piston head by means of a foot valve. In both up and down strokes, the piston action is automatically cushioned, relieving the jar on the doors, lever pins, levers and the cylinder itself.

The two illustrations show the fire door open and closed. The door ring is attached to the locomotive boiler by the studs *A*. The door guides are bolted to the door-ring by stud-bolts *B*, and an upright plate, to which the air cylinder is fastened, is attached to the right hand ends by bolts *C*. The foot-valve, which is operated by a pedal, is fastened to the end of boiler by the stud-bolts *D*, which are the only additional holes necessary to be made in boiler other than required for the swing door. It will be seen from the illustrations that the fire door is composed of two distinct and self-contained mechanisms, each possible to operate entirely independent of the other. These may be properly designated as door parts and air parts. The operation of the former, when disconnected from the latter by the removal of a pin joining the fulcrum lever arm to the piston, is by a hand operating lever.

THE FOUNDRY CUPOLA BLAST

One of the disadvantages of operating two or more cupolas from a single blower is the variable resistance in the cupolas throughout the heat. Under such conditions, which are inevitable, especially if the cupolas are of different size, a constant pressure from the blower means that most of the air will go through that cupola which presents the least resistance, and this condition will obtain until the resistances are equalized. It is becoming recognized that volume is of greater importance for the successful operation of cupolas than pressure, provided, of course, that the pressure is sufficient to drive the air against the resistance. For use in foundries, where power economy is important, the Venturi tube may be used to maintain a constant volume by keeping the drop in pressure at a constant value. When economy is not important a gate or apertured disc will do. Such a volume control on the cupolas will automatically deliver to each the predetermined volume of air. —*The Foundry.*

THE HUMIDITY PROBLEM

Ordinary atmospheric air always has mixed with it some water vapor, which may vary from a very little in cool, dry weather to a much greater quantity in warm and damp weather. For sanitary reasons, as in heating and ventilating and for many industrial purposes, the measurement of this vapor content and its artificial regulation are matters of importance to engineers.

In general, the quantitative composition of a mixture of gases can be found only by chemical analysis. But when one component is a slightly superheated vapor, easily lowered to its temperature of saturation or of incipient liquefaction, a simple physical determination of its amount is possible. At saturation, characteristic pressure and specific volume are both fixed by temperature alone. Further, a given space will contain the same weight of vapor whether this exists by itself, with its own pressure only, or whether it is diffused through a larger mass of gas, under the higher combined pressure due to vapor plus gas. If the "air" in a unit of volume is partly vapor of water, there will be fewer oxygen and nitrogen molecules than if no steam molecules were present.

Air carries its maximum content of vapor when the latter is in the state of saturated steam, ready to begin to condense on the least abstraction of heat; and the air itself is then said to be saturated with vapor. If less vapor is present, it may be considered as having been superheated from some lower temperature of saturation, under the pressure belonging to that temperature. Since vapor tension or saturation pressure rises with temperature, so does also the weight of vapor which a given weight of pure air can carry.

On these principles of thermal physics are based two methods of vapor determination. By slowly cooling a polished-metal surface and observing the temperature at which it just begins to be clouded with condensed vapor, the dew point or temperature of saturation for the actual atmosphere is found. The weight of a cubic foot of saturated steam at this temperature measures absolute vapor content or humidity, to be compared with the possible content at the higher prevalent temperature in order to get relative humidity.

Again, when water and nonsaturated air are in contact, vapor tends to be formed until the air becomes saturated. Vaporization absorbs heat, which may come from several sources, as from the air or water or from the surrounding bodies. If an original air and vapor mixture is the only source of heat, evaporation of enough vapor to saturate it will produce a definite degree of cooling. Practically, a current of air is blown over the wetted surface of a sheathing of cotton wicking wrapped around the bulb of a thermometer. After a short time for the establishment of stable conditions, this wet bulb will be lowered to a temperature such that the latent heat of the vapor formed will equal the sensible heat lost by as much of the air current as would be saturated by this vapor, at the temperature of formation of the latter, or of the water. Since the sample of air takes up vapor in addition to its original content, wet-bulb temperature is higher than dew point.

The wet-bulb apparatus is called a psychrometer. In a paper by W. H. Carrier, on "A Rational Psychrometric Formula," presented at the recent annual meeting of the American Society of Mechanical Engineers, the thermal relations involved in the action just described are clearly developed, and by means of charts are put into shape for convenient use. To the ideal operation of saturating air by vapor formed wholly at the expense of its own sensible heat, Mr. Carrier gives the convenient and accurately descriptive title of "adiabatic saturation."

The effects of humidity and the problems of air conditioning may now be briefly suggested.

The dew-point idea, in excess, is illustrated by the sweating of cold-water pipes, etc., in summer, and by the condensation on the windows of warm and moist rooms in winter.

The wet-bulb idea is best exemplified in the drying kiln, as for drying lumber. Heat to vaporize the moisture in the wood comes almost wholly from the hot air blown into the kiln, so that this air is subjected very nearly to adiabatic saturation.

In the cooling tower, on the other hand, evaporation is induced by air currents, but latent heat is supplied by the descending stream of warm water, intended to be cooled by the action. Consequently, the saturation capacity is that of air at but little less than the initial temperature of the warm water.

In heating and ventilation, the problem is to add vapor to winter air, which is made ex-

cessively dry and thirsty by raising it to indoor temperature; of course, the formation and heating of this vapor is an added burden on the heat supply. If air is cooled for summer ventilation, some of the vapor already present must be removed, most readily by supercooling, condensation and separation, to be followed by a partial reheating of the air.

When humid air is compressed, and after the heat of compression has been dissipated, most of the original vapor content is precipitated; as the total pressure is greater, the vapor tension (although absolutely the same for a given temperature) becomes relatively less, with a resulting decrease in the weight of air that can be carried by a unit of dry air. Unless the air is cooled near the compressor and the water is precipitated, there will be an accumulation in the pipes, with possible freeze-ups in winter, and perhaps trouble with the tools and the machines using the air.

In the operation of the blast furnace, dry air is most desirable, since water vapor is dissociated in the very hot zone just within the tuyeres, absorbing heat which is there much needed for the metallurgical reactions; hence the recent, most advanced scheme of refrigerating and thus drying the blast between blowing engines and blast ovens.

In all the examples so far cited, the vapor tension and the quantity are relatively small, but at the low pressures in steam-engine condensers, vapor volume is of the same order of magnitude as air volume, in a saturated mixture. For better effect in maintaining vacuum, modern condensers are so arranged as to produce localized and progressive cooling toward the outlet to the air pump, thus diminishing the proportion of vapor and the total volume of the mixture going to the air pump.—*Power.*

UNEXPLAINED AIR BLASTS IN MINING REGION

The recurrence of severe "air blasts" in the copper country of Michigan revives the question as to their cause. It has been stated, and is generally believed, locally, that the "air blasts" are due to the sudden displacement of large volumes of air, caused by the falling of great areas of the unsupported hanging walls in the old workings of some of the deep mines, notably the Quincy. A great deal of evidence tends to support this, but a brief review of the phenomena, with the attending results, leaves room for doubt as to whether or not the dropping of this rock is the initial cause.

The first serious shock is believed to have occurred during the summer of 1904. Data available indicates that it was at this time that serious caving was recorded in the old Atlantic mine, situated about two miles south of Portage lake. This first shock attained the proportions of a local earthquake and it was stated at the time that the tremors were felt as far as Marquette, about 90 miles distant, and at the Soo, several hundred miles from Houghton. It is certain that the blast was severe in the immediate vicinity of Portage lake, and was felt distinctly on the shores of Lake Superior, 10 miles north at what is known locally as the canal. Windows, china, pictures and chimneys throughout the district were broken, and all the effects of a light earthquake were noted. Lighter blasts occurred from time to time. During this period, caving continued at the Atlantic mine and finally in 1906 necessitated the abandoning of the property.

About this time serious caving began at the Quincy mine. Up to the present, this has accompanied each "air blast" and several times has caused temporary shutdown of one or more of the Quincy shafts, contiguous to the affected territory. The disturbances occurring in the last few weeks are apparently as severe, as regards surface evidence, as those of 1904 and 1906, and some of the reports regarding them are of particular interest. Several minor shocks preceded the main one, which is said to have centered in the vicinity of No. 7 shaft at the Quincy mine. Buildings on both sides of the lake were shaken, pictures knocked from the walls and crockery broken. Several chimneys were also dislodged. A boat unloading coal at one of the docks was noticeably swayed.

Some of the attending circumstances of many previous shocks are interesting. It has been noticed that before any tremors are observed, there occurs a dull but distinct thud, similar to that caused by a heavy object falling on soft earth. An instantaneous pause follows, after which come the vibrations. With the exception of the severe shock during the summer of 1904, it is safe to say that the great majority of the others have followed sudden

changes, of some sort, in the weather and have happened in the autumn or spring months. The relation is doubtful but interesting.

A somewhat discredited explanation attributes the "air blasts" to a slipping of certain rock strata. This would place the disturbances in the earthquake class and in this connection it is interesting to note the remarks of a local pioneer. He states that the region was subject to tremors and quakes before any mines were opened. It is said that the "Indians knew of the country as 'rolling island' and entertained a wholesome fear of the district, believing it was the habitat of evil spirits." To date there does not appear to be a satisfactory or convincing explanation. Correspondence *Engineering and Mining Journal.*

AN AIR PRESSURE WATER TANK EXPLODES

Many small towns in Central Iowa and elsewhere use the air pressure water system, a sufficient volume of air being pumped simultaneously with the pumping of the water to maintain the required pressure in the tanks, thus dispensing with elevated reservoirs. This system has been in use for several years at Jessup, Iowa, and has proved highly efficient not only supplying all the inhabitants, but having already saved the town from several destructive fires. Recently, however, the tank, horizontal, 8 ft. diameter and 3 ft. long, exploded, destroying the building and wrecking pump and engine. The engineer had left the building, so that no one was injured. The writer, who sent an account of the catastrophe to the press, wrote: "It appears as though a safety valve should have been provided on the tank." We are not prepared to believe that a thing so necessary was not provided. We are constantly being reminded, however, that all automatic devices are not always and forever to be relied on if never inspected and cared for.

OZONIZED AIR FOR LONDON SUBWAYS

Much complaint is made of the condition of air in the London "Tube." It is announced by the Central London Railway Company that a system of ventilation will be installed capable of pumping daily 80,000,000 cubic feet of ozonized air into the stations and tunnels. In fact one plant is already in operation and it is hoped that similar ones will soon be completed at every station along the line. It is stated by one of the officials that the plant at each station will pump 400,000 cubic feet of air per hour into the station, or at the rate of 900 cubic feet per person per hour. The ordinary allowance in buildings is about 300 cubic feet of fresh air per person. The air is drawn from outside through a filter screen, which removes dust and dirt and impure gases. A part of the air is then ozonized by being passed over highly electrified plates. The air is driven by fans to the level of the bottom of the station, and two-thirds of it is distributed over the platform by ducts, with outlets at a height of 7 feet above the platform. The remainder is driven into the tunnel.

LAUNDERED AIR

[This poem was inspired by a description of a ventilating system, which states: "All windows in the office are kept closed and a constant circulation of fresh air is induced by means of rotary fans, and all air is washed and heated or cooled to proper temperature before being driven into the distributing ducts." It appeared in "Ryerson's Monthly."]

I can stand for tainted money, I can stand for tainted grub;
I can drink polluted water and employ it when I scrub,
But since noting this invention I shall never, I declare,
Be content again with breathing anything but laundered air.

Give me clothing filled with shoddy, filled with microbes, if you will;
Let a million microbes bite me when I touch a dollar bill;
Let the germs come swarming o'er me when I take an easy chair,
But I pray you do not give me anything but laundered air.

If ozone may be laundered, can't we neatly crease it, too—
Hand it round in snowy bundles like the laundry people do?
Oh, I hope the time is coming when to laundries we'll repair.
Bright and early Monday mornings for our week's supply of air.

National Laundry Journal.

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EVERYTHING PNEUMATIC

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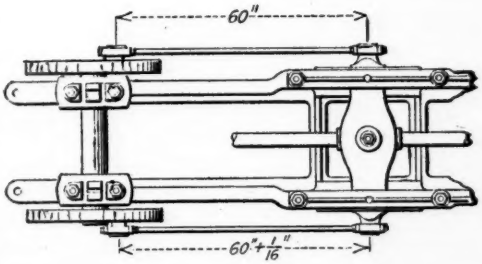
KNOCKING IN AIR COMPRESSORS

The following letter from a contributor, which we reprint verbatum, recently appeared without comment in *Power*:

"A double connecting-rod air compressor will frequently knock badly unless the air valves are in good condition and the steam valves are properly set. The knock is caused by the elastic spring of the air in the air cylinder acting against the steam piston when the steam is expanding, due to the cutoff. This trouble can be eliminated in part by setting the steam valves so as to allow plenty of steam to follow up the piston and not cut off too early. Straight-line compressors should have the valves set on the steam end so that the air valve will be closed on the compressor end when the steam piston is nearing the end of its travel; otherwise the elastic body of air will cause a bad hammer. Some knocks are caused by a wearing of the side-rod brasses. I have found them on double-rod machines so worn that one rod would be 1-16 inch longer than the other. Sometimes the crank pins are not equally distant, as shown in the illustration. New babbitt in the crankshaft bearings or thin copper liners between the end of the connecting-rod brasses on the short-rod end would remedy the defect."

Baltimore, Md.

C. R. McGAHEY.



The sketch shows a "straight-line" compressor of the familiar type. The steam cylinder, not shown, is between the crosshead and the crank shaft, and the air cylinder is outside, or to the right of the sketch, although the relative location of those cylinders might be quite different without changing the running conditions. The knock referred to certainly is *not* "caused by the elastic spring of the air in the air cylinder acting against the steam piston when the steam is expanded, due to the cutoff," whatever all that may mean. The

cutoff is adjusted to suit the steam and air pressures and could not affect the knock, one way or the other. It is well known that in straight line compressors, with the air and the steam cylinders usually of the same diameter, the steam power at the beginning of the stroke is considerably in excess of the air resistance, and the surplus of power goes to accelerate the fly wheels, their momentum thus acquired serving to help out the latter part of the stroke when the steam power runs down to almost nothing and the air resistance is at the maximum. The knock is caused by the reversal of the connecting rod function in mid-stroke. If the thrust of the crosshead is downward at the beginning of the stroke it will be upward at the end of the stroke, and *vice versa,* and the only thing to do about it is to keep main bearings and connections set up as snugly as possible, and especially to have no vertical play between the crosshead and the slides over or under.

A slight difference in the lengths of the two rods is not a serious matter, as the crosshead is swiveled to compensate for that. If the writer had taken off both of the rods and accidentally or otherwise, had shoved one end of the crosshead forward or backward he might easily have found a difference of an inch or two between the two sides instead of the one-sixteenth reported.

FLYWHEEL ROTATION AND CROSSHEAD PRESSURE

"In air compressors where the air cylinders are directly behind the steam cylinders, running the compressor under brings the pressure of the crosshead on the lower guide; running it over brings the pressure on the upper guide, the tendency being to lift the machine from the foundation."—*Exchange.*

When the crosshead pressure is against the upper guide the tendency to lift the machine from its foundations is the same as that which a man experiences when he lifts himself by pulling on his boot straps.

In a straight-line, steam driven compressor, the crosshead pressure will be downward for a portion of the stroke and it will be upward for the other portion, no matter in which direction the shaft turns, for in the first half, more or less, of the stroke the steam will be doing the compressing and at the same time will be increasing the momentum of the flywheel, while in the other half of the stroke the conditions will be reversed and the flywheel will be helping the steam.

OZONE AS A PURIFYING AGENT

Although ozone is obtaining extensive recognition and industrial employment, current definitions of it are far from satisfactory. It is known that ozone is a colorless gas with a peculiar odor, and that is about all. It may be considered as a condensed oxygen and is one of the most powerful of sterilizing agents. It is produced in the atmosphere by lightning discharges, a process of oxidation and water evaporation and is not found to any extent in the air of the streets of our cities and consequently is a negligible quantity in the ordinary dwelling rooms of our great centers of population. But on the contrary it is found in the forests, sea-shores and mountains, especially during the spring and in agitated damp air, during gales and snowstorms.

Ozone oxidizes metals, whitens colored objects, destroys all kinds of organic matter found in dust, and other impurities of the air, as well as the microorganisms contained in water. On account of the decomposition which accompanies this oxidation, the ozone gives out one-third of its oxygen rendering most valuable help to modern sanitation, and ozonating plants have been installed successfully in Europe and America.

Whenever there exists a surplus of ozone, the absolute absence of oxidizable matter, or impurity in the air, is guaranteed. It is a fact that oxygen is the only product of reaction, and is the gas of greatest importance in giving the ozone undeniable superiority as a sterilizer. It was not until very recently that the construction of proper ozonators made it possible to use ozone effectively in sanitation. The devices constructed by Siemen and Halske transform the atmospheric oxygen into ozone by means of electrical discharges at high tension.

The city of St. Petersburg has just made an important application of this agent for the purification of water of one city, by installing a complete plant for ozonating water. The water in St. Petersburg was supplied by three great plants, of which only one (the greater one) had sand filters, while the other two were supplying water, such as it was, direct from the Neva. The new plant for the supply-

of ozonated water was built on the premises of one of the two latter plants (that of Penkovaya) and it is capable of supplying 50,000 cubic meters (14,000,000 gals.) per day.

Before applying the ozone, the water is subjected to a preliminary purification by passing through rapid filters into reservoirs where by means of sulphate of alumina the matter contained in the water is precipitated. After this process of clarification the water is subjected to ozonation.

There are eight reservoirs for clarification connected with each other by means of conduits and equipped with 38 rapid filters. These are made according to Howamtson system which is almost similar to the American method of Jewell. The principal difference between the two is that Howamtson uses flint especially prepared for filling the filters in place of ordinary fine sand.

The filters are cleaned by washing them with filtered water and at the same time the flints are altered by means of special removers. The filtered water goes directly to the sterilizing towers, except a small volume diverted for cleaning the filters.

The ozonating plant proper is composed of two parts: the ozonator battery, and the sterilizing towers. The ozonator battery comprises 126 elements and there are five sterilizing towers, one of the latter being held in reserve. The tubular elements of the ozonator batteries are based as stated above upon the action of high tension discharges between two cylindrical ends of aluminum and glass respectively. It is operated with a relatively elevated concentration of ozone (2.5 per cubic meter of air).

Before going through the ozonators the air is dried by refrigerating process in order to give the best results. Then it is blown through the ozonators by means of special conduits that absorb the ozonated air at an area of pressure of four meters of water, in order to mix it and pump it into the sterilizing towers. The absorption of ozone and the sterilizing of filtered water takes place partially in the conduits and partially in the sterilizing towers through which the ozonated air passes from the base to the upper part very finely pulverized, which prepares it for effective diffusion throughout the body of the water. After being aerated the ozonated water is deposited in special large reservoirs from which it is pumped at a high pressure for city distribution.

The plant is operated by an electrical plant equipped with boilers, steam engines, alternators, as well as three sets of high frequency converters through which the three phase current from the main generators are transformed into alternating current of 500 cycles per minute. The ozonators require for their operation a high frequency and high tension current of about 7,000 volts. The power element of the plant consists of two sets of steam engines of 150 H. P. each, connected directly with the three-phase generators. A third set is kept in reserve.

From an architectural standpoint the plant is of special interest. All the large reservoirs for clarification, filters, as well as the columns and roofs of the buildings are built of concrete. This filtering and ozonating plant has fulfilled the hopes entertained as to the effectiveness of its purifying action from a physical and bacteriological standpoint. The dirty water from the Neva is transformed into a perfectly potable, pure, and transparent water, and is irreproachable from a sanitary standpoint, as it contains absolutely no typhoid fever, cholera, or other germs.

Two other installations of the same kind will be completed within this year for ozonizing the water supply of the City of Paris with a capacity of 46,000 cubic meters (13,000,000 gals.) each.

AERATOR NOZZLE TESTS

During the latter part of 1910 the Board of Water Supply of the City of New York conducted a series of tests to determine what type of nozzle would be most suitable for aerating the water at the Ashokan and Kensico reservoirs. The results of these tests are given in the 1910 report of Mr. J. Waldo Smith, chief engineer.

The results fully demonstrated, according to the report, the practicability of casting a thin shell with spiral vanes in one piece and determined the form of the nozzles to be used. Each nozzle consists of a cylindrical base surmounted by a conical tip. In the base are cast three vanes, equally spaced on circumference, and projecting nearly to the center of the waterway. At the bottom the vanes are parallel to the axis of the nozzle and above are curved to an inclination of about 60 deg. at the top. The function of the vanes is to set up a rotary

motion in the water issuing in a solid stream at the tip and to aid in breaking it up promptly into drops. As in the earlier tests, it was observed that the rotary motion of the water gave the jets greater resistance to distortion from air movements, as compared with jets from nozzles without vanes. Three types of nozzles were constructed, a short-tipped, a long-tipped and one without tip; the base, including the vanes, was the same for all types.

Measurements of nozzle discharge were made by observing the drop of the water surface by a hook guage in the tank during fixed intervals, together with careful observations on the height, spread and general shape of the jet. Coefficients of discharge were computed and the effective head at the base obtained by a pressure gauge. The coefficient for the nozzles with tips, both long and short, was about 0.9 and for the nozzle without tip about 0.6 No advantage in shape, jet or coefficient was shown by the long-tipped or the short-tipped nozzle over the other. The nozzle without tip produced a marked division of the jets into three parts, which was especially manifest in the top of the jet. The report states that it is probable that placing the vanes a little deeper into the butt would produce a more regular form. A commercial nozzle gave a symmetrical jet with high coefficient, 0.96, but the spray was not as finely divided as the jets from the Board's nozzles, and for the proposed use the spread was considered undesirably greater.

PROPORTIONS OF EXPLOSIVE MIXTURES

Some interesting experiments to determine the limits of explosiveness of mixtures of air and acetylene have been made by Professor Eitner and the Bosnia Electric Company respectively. According to Professor Eitner, a mixture of air and acetylene is explosive when it contains a minimum of 2.9 per cent. acetylene to a maximum of 6.4 per cent. Above the latter degree the mixture ceases to be explosive. On the other hand, the electric company made experiments, not with small quanities like Professor Eitner, but with large amounts, a bell 11 cubic metres in capacity built with masonry being utilized. In this case the explosions took place with 1.5 to 3 per cent. acetylene. In a second series of experiments the constructions utilized were permeable to some extent, to allow communication between the interior and exterior air. To measure the explosive power a weight was placed against the door of the bell, and the quantity of acetylene was varied. With 2.5 per cent. acetylene there was a slight explosion, but with 2.6 the explosion was violent and accompanied by flames. Thus the lowest limit of explosiveness for mixtures of air and acetylene is 2.5 to 2.6 per cent. acetylene.

ASSUAN DAM PROGRESS

The work begun in 1907 of raising the level of the great Assuan Dam by 16 feet, and thus more than doubling its capacity, progressed during 1910 according to schedule. The dam as originally built had a capacity of 1,282,000,000 cubic yards of water, but with the improvements this will be increased to 3,008,400,000 cubic yards. The thickening work was finished from end to end in 1908 and 1909, and last year the locks, which had to be correspondingly raised, were completed to the new levels. An additional water height of 23 feet will be secured from the heightening of the masonry by about 16 feet. This is because the water surface of the original dam, when full, was 10 feet below the top of the masonry, because of the details of the ironwork construction. Experience has shown that such a large freeboard is not necessary and in the new dam the water will reach to within 1 meter of the roadway. It is believed that the additional supply of water will bring 1,000,000 acres of land in Egypt into cultivation.

THE BREATHING CAVE OF ARIZONA

Near Prescott, Arizona, there is a curious natural phenomenon known as a breathing cave. It is in the lava formation on a high tableland near Prescott. In a wall of this cave is a crevice which is probably three inches wide and several feet long. A visitor stands close to this crack. He feels a current of air rushing out of it. This is not so strange But if he waits long enough he will notice that the direction of the current has changed, and the air is being drawn into the crevice. A subterranean stream is given as the probable cause. Just how the flow of an underground river could cause the direction of the air current is not all at once evident, but it is assumed that there is a syphon action which alternately increases and reduces the air capacity of the cave by causing a rise and fall of the accumulated water in it.

NOTES

To thaw out frozen water pipes pack them with unslaked lime and wrap up in old rags or carpet. Pour water over the portions thus covered and the heat generated will melt the ice in the pipes.

The effect of vacuum upon the steam consumption of a turbine is strikingly shown by the reports of a recent test on a one thousand-killowatt machine in which the consumption increased forty per cent. with a decrease in vacuum from twenty-nine to twenty-one inches.

A movement is in progress for building in the Caucasus a tunnel longer than any yet constructed. It is to be double-tracked and 13 miles long, the Simplon tunnel being 12¼ miles. The estimated cost is $50,000,000 and the time required for construction seven or eight years, using for power the mountain rivers of the region.

The first underground pneumatic tube system constructed in this country was at Philadelphia in 1892. This was a 6-inch tube extending about five-eights of a mile from the central post-office to a sub-station. There are now 113½ miles of tubes in operation in five cities, viz.: New York 57¼, Philadelphia 20, Boston, 14, Chicago 18½, St. Louis 4.

It is proposed to connect Venice with the island of Lido by a tunnel 2¼ miles long under the lagoon. This island, a favorite resort of the Venetians, on account of its unrivaled beach and excellent sea bathing, is situated on the Adriatic. The terminus of the line would be in a central position, close to the Piazza di San Marco and the Riva degli Schiavoni, at about 26 feet below the sea level.

Measured by the capital invested, the cement industry is one of the world's three great extractive industries. In capital employed it apparently far outranks the gold-mining industry of the United States, including Alaska, as well as the copper industry. Only coal and iron stand ahead of it. The price of Portland cement in 1910 was as low as 73 cents a barrel in some places, the average for the United States being 89-1 cents a barrel. In 1890 the average price was over $2 a barrel and as late as 1903 it was $1.24 a barrel.

The American submarine Salmon has established a record for deep diving, which is said to exceed anything that has been hitherto accomplished in the American navy. During the early summer months the Octopus attained a depth of 125 ft. This has been exceeded by 19 ft. by the Salmon, which was submerged to a depth of 144 ft. off Prudence Island, and remained at that depth for twenty minutes.

A blow-out occurred in driving a compressed-air tunnel under Chelsea Creek, Boston, Mass., to carry one of the pipe lines for the distribution system of the Metropolitan Water Board. The tunnel line crossed a spot where a number of timber piles had been driven and withdrawn. The holes left when the piles were removed filled in with soft material, and when the subaqueous work crossed one of these holes the air blew out through the soft mud and water rose in the tunnel to the height of a man's chest.

As the oxygen percentage in air diminishes, the flame of a candle or lamp is affected in two ways. In the first place the light emittted steadily diminishes. Roughly speaking, the light of a candle or lamp diminishes by 30 per cent. with a fall of 1 per cent. in the oxygen percentage, and the flame will no longer burn when the oxygen has fallen from the normal (20.93 per cent.) to about 17.5 per cent. A further effect is that the flame becomes less and less stable and it is more and more easily blown out by any chance draft or movement.

At Notodden, Norway, in 1905, the first factory for manufacturing nitric acid directly from the elementary gases of the atmosphere was erected. In an enlarged form it now gives occupation to 500 workmen, and is daily demonstrating the remarkable possibilities of this new factor in chemical industry and in economic evolution. The factory furnishes all the nitrates required by Norway in agriculture and the arts, and is shipping constantly increasing quantities to foreign countries.

Almost perfect combustion can be obtained by mixing air in proper quantities with pulver-

ized coal before the latter is introduced into the furnace. Less air is necessary than usual and the method greatly reduces the amount of heat carried away in escaping gases. The fuel is burned in suspension and the amount of unconsumed coal is very small. Coal dust which would otherwise be waste is thus made to do better work than a solid product costing much more. Another advantage is that the fire may be cut off very quickly, in a manner analogous to the turning off of gas from a jet.

At Elk City, Kans., the Missouri Pacific operates a pumping-station with a blind mule. The mule is left alone all day and goes around and around pumping water. When the tank is full the water splashes out on a sheet of zinc and the noise is the signal for the mule to stop. When a train comes along and takes water the mule begins to pump again until the water splatters. The owner of the mule got out last spring and worked against and helped beat the waterworks bonds at the election, because the construction of a waterworks system there would throw his blind mule out of work.

What is probably a Yorkshire record in coal mining, if not a world's record, has been achieved at the Hickleton Main Colliery. Recently the tonnage raised during six days reached a total of 26,986 tons, from a seam which is known as the Barnsley bed. Another record for the week ending Oct. 24 is 25,572 tons from the Crown Farm Pit of the Bolsover Colliery Company. This amount was mined in the time of five days and a half, each of 7 hours and 5 min. duration, only one shift per day being worked. It is said that this latter mine holds the world's record for a day's output, which is 4678 tons of coal.

Admitting compressed air into the gas engine cylinder at the end of the exhaust stroke is proposed in a recent issue of the Zeitschrift des Vereines Deutscher Ingenieure. It is recognized that the residual of the burned gases remaining in the cylinder and mixed with the new charge dilutes the fresh mixture, impoverishes it, and generally interferes with the ignition of the charge, unduly elevates the initial temperature, predisposes the motor to premature explosion and affects the efficiency of operation. The author showed by means of diagrams and figures of a number of tests how the efficiency was increased as the result of the adoption of the valve which admits the air under pressure at the end of the exhaust stroke.

Hard steel is now cut with plain discs of mild steel rotated at high speed. The discs are of boiler plate quality steel and about ¼ in. thick. They are run at about a speed of 20,000 ft. a minute. It is said that one of the discs will cut through a heavy channel section of hard steel, 12 in. by 6¾ in., in 15 seconds. The disc remains cool while cutting because of its large surface area and small point of contact. The metal cut also remains cool for a similar reason, although at the point of contact with the disc the temperature is very high. The explanation of this apparently wonderful feat is that all the frictional energy of the disc is concentrated on an extremely small area of contact, and the cutting is accomplished apparently by local fusion.

A half part per million of iron in water is detectable by taste and more than 4 to 5 parts make a water unpalatable. In some mineral springs iron is the constituent which imparts a medicinal value to the water but ordinarily it is undesirable. More than 2.5 parts per million in water used for laundering makes a stain on clothes. Iron must be removed from water from which ice is made or a cloudy discolored product will result. An iron content of over 2 or 3 parts per million in water used in the manufacture of paper will stain the paper. Iron is harmful in water used for steaming, for it is in equilibrium with acids which inside the boiler become dissociated, with the result that the free acids corrode the boiler plates; but the amount of iron carried in solution by most waters is so small that the damage it does to steam boilers generally amounts to little.

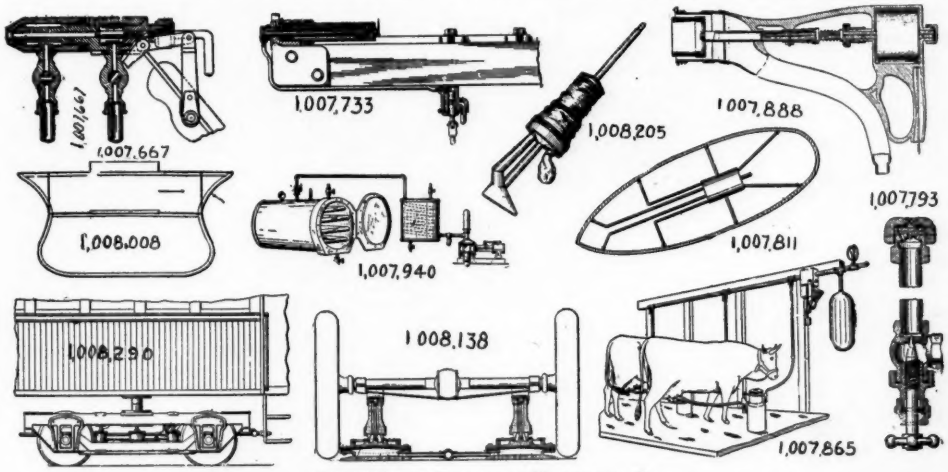
A simple way of making telephone conversations more audible has been invented by Herr Petersen, a bank manager of Nykjobing, Denmark. On the principle that sound is more readily transmitted through rarefied air he has constructed an aparatus to warm the transmitter, whereby the air in it becomes thinner and the sound is intensified. Prof. Hanover of the

Danish Government telephone testing station, who has made extensive experiments with Petersen's apparatus, says in his report that the increase of sound obtained is remarkable. Telephone conversations between Copenhagen and Nykjobing, a distance of some seventy-five miles, could be clearly followed some distance away from the instrument. The inventor has applied for patents in different countries.

The Secretary of the Treasury proposes to establish in the near future a pneumatic-tube service between the Bureau of Engraving and Printing and the Treasury Department, a distance of six city blocks, for the transportation of millions of dollars of paper currency, stamps and securities. The transportation is now accomplished by means of big steel vans, guarded by half a dozen armed men and a number of mounted guards. No attempt has ever been made to hold up these vans, but the underground tube is considered advisable, more for economic reasons than as a precaution against robbery.

Glass gradually softens as it is heated until further heating produces no further change. It does not become a freely flowing fluid at any temperature, but only a thick viscid substance which flows like cold molasses. Different kinds of glass begin to soften at widely different temperatures. Any glass may be heated probably 400 to 600 degrees F. without becoming soft.

Sewage ejectors operated by compressed air have been found serviceable in a number of English cities for raising the sewage of small districts too low to discharge into the main gravity system. At Frodingham, for instance, there are 90 houses with sewers draining to two chambers containing Coomb's pneumatic ejectors, each rated at 60 gal. Air is furnished by a motor-driven compressor provided with an automatic control. Current is obtained from the plant of a neighboring steel mill. When the pressure in the receiver of the ejector falls below that necessary for its operation, the motor is started automatically and continues in operation until the pressure has been raised to the upper limit is considered advisable for satisfactory performance of the ejector.



PNEUMATIC PATENTS, NOVEMBER 7.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 7.

1,007,667. PAINT-SPRAYER. FREDERICK W. BALLARD, Cleveland Heights, Ohio.

1,007,733. PNEUMATIC PICKING MECHANISM. EDGAR RHODES, Scholes, near Leeds, and WALTER RHODES, Leeds, England.

1,007,793-4-5. ATOMIZER OR SPRAYING DEVICE. ERNEST H. PEABODY, New York, N. Y.

1,007,811. FLUID-JET-PROPELLED VESSEL. PERRINE G. SOMMERS, San Diego, Cal.

1,007,865. PULSATING DEVICE FOR MILKING APPARATUS. EZRA E. GOOD, Waterloo, Iowa.

1. In a milking apparatus, the combination with a pump pipe and a service pipe, of an automatic pulsating device connected between said pump pipe and said service pipe and operating intermittently to alternately connect said two pipes and to open said service pipe to the atmosphere, but at all times cutting off atmos-

pheric air from said pump pipe, a multiplicity of milk cans, milk conduits leading into said cans, independent air conduits leading from said cans to said service pipe, and devices applied to said cans, when air is admitted into said service pipe, by operation of said common pulsating device.

1,007,888. VACUUM CLEANING DEVICE. PITMAN W. PARKER, San Diego, Cal.

1. In a device of the character described, the combination with a vacuum tube, of a brush mounted at the mouth of said tube, and power means for imparting constant rotative and reciprocatory movement to said brush.

1,007,940. PROCESS OF DRYING EDIBLE PASTES. FRANK M. GREGG, Cleveland, Ohio.

1. A process of drying edible pastes which consists in placing the pastes in a receptacle, exhausting the air from the receptacle and alternately raising and lowering the temperature while the reduced air pressure is continuously maintained.

1,007,955. COMPRESSED-AIR WATER-ELEVATOR. GEORGE S. LANE, Portland, Oreg.

1. In a pump, a cylinder, means for admitting water into said cylinder, means for admitting compressed air into said cylinder to displace the water and means for permitting the escape of air from said cylinder to permit water to enter the same, means for controlling the admission of air to and the escape of air from said cylinder, means for conveying the displaced water from said cylinder and a water motor operated by the water conveyed from said cylinder for operating said air admission and escape controlling means.

1,008,008. CONSTRUCTION OF SHIPS. ARTHUR CLIFTON CAINES, Swansea, England.

1,008,076. PORTABLE PNEUMATIC REVERSIBLE DRILLING-MACHINE. CHARLES SCHOFIELD, Newcastle-upon-Tyne, England.

1,008,123. AIR-CONDITIONING APPARATUS. FRANK E. DONALDSON, Palos Park, Ill.

1,008,138. LIFTING-JACK FOR AUTOMOBILES. GEORGE C. HALE, Kansas City, Mo.

1,008,205. VACUUM CLEANING APPARATUS. JULIUS SCHIRRA, Pittsburgh, Pa.

1,008,228. METHOD OF MAKING PAPER. PHILIP WESTON, Dalton, Mass.

1. The method herein described, of manufacturing paper having a thinned portion, which consists in removing from the web at the portion to be thinned, some of the material by the application of air pressure thereto.

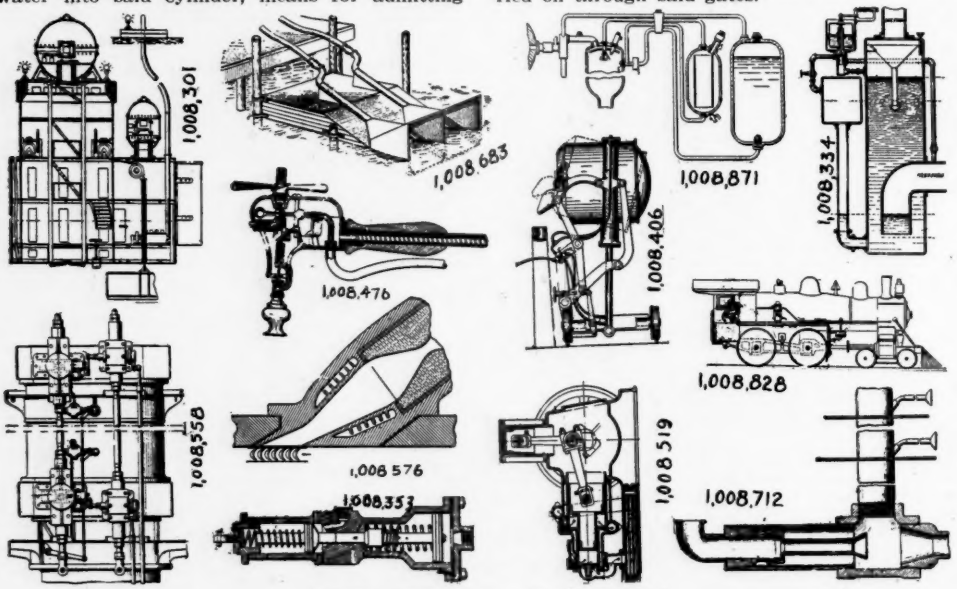
2. The method herein described, of manufacturing paper having a thinned portion, which consists in removing from the web at the portion to be thinned, some of the material by the application of suction thereto.

1,008,290. AIR-CUSHION FOR VEHICLES. REGINALD T. VERGE, Halifax, Nova Scotia, Canada.

NOVEMBER 14.

1,008,301. SUBMARINE WORKSHOP. WILLIAM H. BAKER, Bridgeport, Conn.

1. A submarine structure of the character described provided with a bottom wall, a working floor of equal era with said bottom wall, the space between said bottom wall and floor forming a ballast compartment, a living room above said floor, means of supplying air to said living room, and centrally located gates in said bottom wall and floor, whereby when the pressure within the structure is equal to or greater than the water pressure operations may be carried on through said gates.



PNEUMATIC PATENTS, NOVEMBER 14.

1,008,334. REGULATOR FOR GAS-WORKS. GEORGE C. HICKS, JR., Connersville, Ind.

1,008,353. AUTOMATIC RETAINING-VALVE FOR AIRBRAKE SYSTEMS. ARCHIBALD MILLIGAN, Ogden, Utah.

1,008,368-9. PNEUMATIC COW-MILKER. JOSEPH RIPCZINSKE, Wausau, Wis.

1,008,406. PORTABLE FURNACE. MERRILL DAVIS, Watertown, N. Y.

1. In combination, a tiltable and rotable furnace mounted on trunnions, a pair of *fluid pressure actuated hoists* for supporting and operating the furnace, an elevating mechanism for rotating the furnace during the pouring operations, and a valve carried by parts of said elevating mechanism adapted to control said hoists.

1,008,415. PNEUMATIC STRIKER APPARATUS. MACARIUS MAXIMILIAN KASTNER and CONRAD KATZ, London, England.

1,008,476. FLUID-ACTUATED VIBRATOR. JAMES B. KIRBY, Cleveland, Ohio.

1,008,519. AIR-COMPRESSOR. HARRY EDSIL BARR, Erie, Pa.

1,008,558-9. BLOWING-ENGINE OR COMPRESSOR. GUSTAV B. PETSCHE, Philadelphia, Pa.

1,008,576. METHOD OF AND APPARATUS FOR ALTERING THE CONDITION OF GASES. KARL AHLQUIST, Rugby, England.

1. The method which consists in taking a supply of relatively hot gas under pressure at low velocity, increasing the velocity and kinetic energy of the gas by expansion under suitable conditions, then cooling the gas, and utilizing the energy so obtained to compress the gas to a desired pressure by discharging it at the high velocity due to the previous expansion and cooling under such conditions that more or less of its energy of velocity is converted into pressure, substantially as described.

1,008,627. PNEUMATIC-DESPATCH-TUBE SYSTEM. FRANKLIN H. WOLEVER, Chicago, Ill.

1,008,683. WAVE-ACTUATED AIR-COMPRESSOR. ENOS A. WALL, Salt Lake City, Utah.

1,008,703. CAR-COOLING DEVICE. JOHN DANIEL CUNNINGHAM, Marietta, Ga.

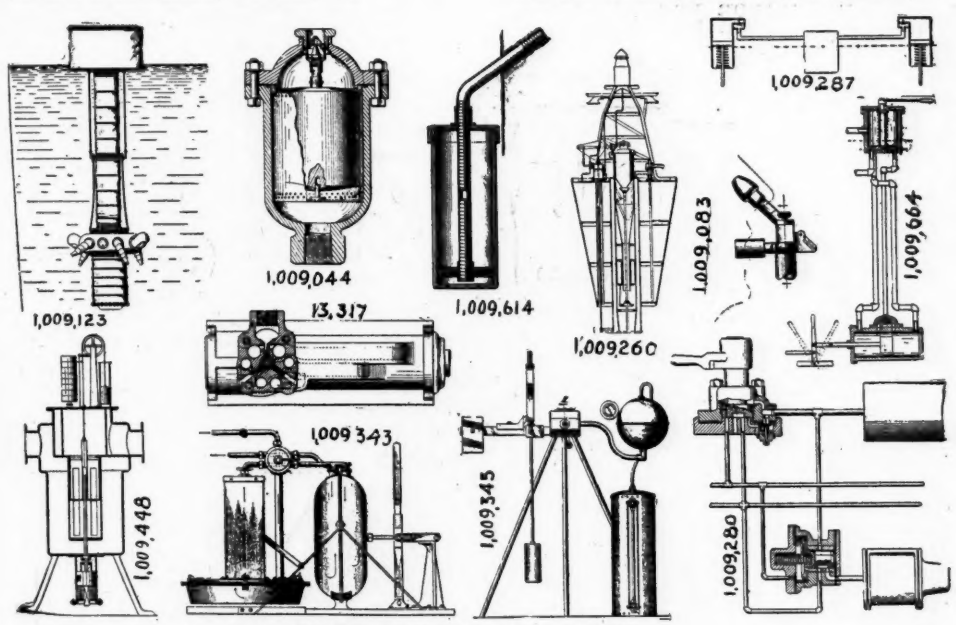
the spray valve and adapted to spray the lubricant on the wheel flange and the rail.

1,008,865. VACUUM ATTACHMENT FOR CARPET-SWEEPERS. JULIUS SCHIRRA, Pittsburgh, Pa.

1,008,871. MEANS FOR INCREASING ENERGY OF STORED COMPRESSED AIR OR OTHER GAS CAPABLE OF SUPPORTING COMBUSTION. WILLIAM HORACE SODEAU, Newcastle-upon-Tyne, England.

1. Apparatus for increasing the energy of stored compressed air comprising in combination a combustion chamber into which said air is admitted, a fuel reservoir and a supply of vaporizable liquid, said vaporizable liquid on its passage to the combustion chamber being divided into two streams one of which displaces from the fuel chamber an amount of fuel proportional to the amount of vaporizable liquid flowing directly to the combustion chamber.

1,008,884. AUTOMATIC SEWAGE-EJECTOR. WILLIAM P. ANDERSON, New York, N. Y.



PNEUMATIC PATENTS, NOVEMBER 21.

1,008,712. HYDROVACUUM-CREATOR. JAMES J. GORMAN, Durango, Colo.

1,008,712. POWER SYSTEM. WILLIAM E. ADAMS, Salem, Mass.

1. The combination with an internal combustion engine having an air jacket around its combustion cylinder, of an air compressor driven by the internal combustion engine and supplying air to the air jacket, an air reservoir connected with the air jacket to receive the heated and compressed air therefrom, and means co-operating with the air compressor for controlling a supply of compressed air from the reservoir to the air compressor to start the engine, substantially as described.

1,008,828. LUBRICATING SYSTEM. WALTER A KEITH, Los Angeles, Cal.

1. In a lubricating system, for railway rolling stock, means to distribute the lubricant on the wheel flange and the rail, comprising an oil tank in communication with an air supply under pressure having an air-regulating valve thereon, a discharge pipe extending from the oil tank, a spray valve connected with said oil discharge pipe, a pipe connecting the spray valve with the air supply, and a nozzle extending from

NOVEMBER 21.

1,009,044. VENT-VALVE FOR WATER OR OTHER LIQUID CARRYING CONDUITS. EDWARD BURGESS, Brixton, London, England.

1,009,083. AIR-SUPPLY ARMOR. CHRISTOPHER MCNAMEE, New York, N. Y.

1. In a device of this character, the combination of a body garment provided with an air-chamber, means for supplying air thereto, a conduit for conveying the air from the air-chamber, and a respiratory device connected to said conduit and comprising a casing, two nostril entering tubes carried thereby, and a valve controlled mouth-piece said mouth-piece and tubes being separate from each other and out of communication with each other.

1,009,123. APPARATUS FOR RAISING SUNKEN VESSELS. CHARLES WILLIAMSON, Norfolk, Va.

1,009,205. AIR-PURIFYING APPARATUS. WELLINTON P. WINTER, Toledo, Ohio.

1,009,220. DRESSING-DELIVERING MECHANISM. CHARLES F. BURKHART, Buffalo, N. Y.

1. In a device of the class described, the combustion with a foot rest, of a dressing tube movable past the same, means for supplying dressing to said tube, an air blast tube discharging across the end of said dressing tube and directing its discharge toward a shoe on the foot rest, means for normally closing said dressing tube, and means for opening the dressing tube.

1,009,260. VACUUM-GENERATING WAVE-MOTOR. GUSTAF VON POST, Stockholm, Sweden.

1,009,286. DUPLEX-PRESSURE EMERGENCY AND STRAIGHT-AIR BRAKE. JOHN S. CUSTER, Pittsburgh, Pa.

1,009,287. COMPRESSED-AIR SUSPENSION FOR VEHICLES. LEON DELPEUCH, Neuilly-sur-Seine, France.

1,009,316. PNEUMATIC-DESPATCH-TUBE APPARATUS. CHESTER S. JENNINGS, Boston, Mass.

1,009,343. REGULATOR FOR PUMPING-ENGINES. WILLIAM K. RICHARDSON, Leavenworth, Kans.

13,317. (Reissue). VALVE-MOTION FOR ROCK-DRILLS. LEWIS CONDICT BAYLES, Easton, Pa.

NOVEMBER 28.

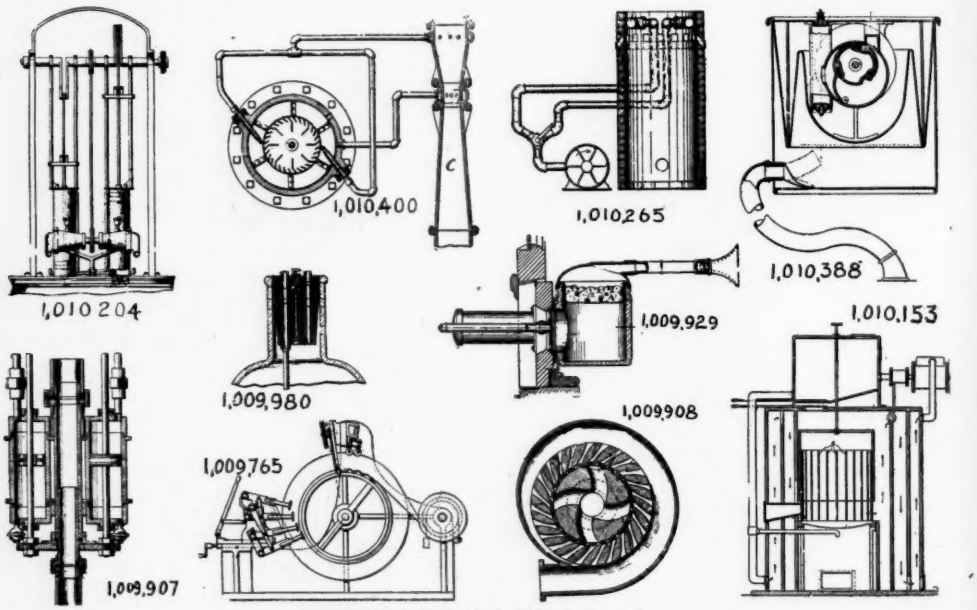
1,009,723. AIR-REGULATING DEVICE FOR OIL-BURNING FURNACES. KNUT M. DAHL, San Francisco, Cal.

1,009,765. MACHINE FOR MANUFACTURING PNEUMATIC TIRES. ALPHONSE MATHERN, Berlin, Germany.

1,009,782. VACUUM EVAPORATING APPARATUS. CHARLES ORDWAY, New York, N. Y.

1,009,907. SUCTION-HOSE COUPLING. GEORGE M. KESSLER, Gregson, Mont.

1. The combination with an upright sleeve adapted to be connected at its upper end with a pump, cylinders at opposite sides of said sleeve, pistons therein, piston rods depending from these pistons through the lower heads of the cylinders, and connections for moving the pistons in either direction by fluid-pressure; of a yoke connecting the piston rods and having a



PNEUMATIC PATENTS, NOVEMBER 28.

2. The combination of a rock-lever, a receptacle carried thereby containing air under pressure, means for weighting the receptacle by conducting water thereto to balance or overbalance the opposite end of the lever or for lightening the receptacle by conducting water therefrom until it balances or is of less weight than said opposite end of the lever, a frame pivotally carried by the lever, and means for maintaining said frame in an upright position, irrespective of the rocking movements of the lever.

1,009,448. AUTOMATIC RECORDING APPARATUS FOR MEASURING GASEOUS FLUIDS. CARL FRIEDRICH SIMON, Stolberg, Germany.

1,009,498. PNEUMATIC SPRING. ADOLPH W. FRITZ, Burlington, Iowa.

1,009,499. PNEUMATIC CLEANER. CHARLES BURDETTE GILMORE, Bloomington, Ill.

1,009,641. TURPENTINE-CUP. HERMAN H. BOYER, Pensacola, Fla.

1,009,664. CONTROLLING MECHANISM FOR BOATS. EDWARD HEFTY and ALFRED B. LAMBERSON, Portland, Oreg.

notch in its front edge, a pipe removably engaging said notch and connected at its lower end with a hose, and a cup surrounding the pipe and adapted to make a tight joint with the lower end of the sleeve when it is elevated by the rise of said yoke.

1,009,908. VACUUM-PUMP, OR COMPRESSOR. JOHN A LAFORE, Cynwyd, Pa.

1,009,929. DEVICE FOR THE ADMINISTRATION OF MEDICATED OXYGEN. GEORGE W. PHILLIPS, New York, N. Y.

1,009,980. AIR-PRESSURE CORK. JOSEPH S. LEISURE and PERL J. ROBINSON, Ingleside, Neb.

1,010,153. HOT-AIR ENGINE. JOSEPH KUHAJDA, New York, N. Y.

1,010,204. MILKING-MACHINE. THEODORE UMRATH, Chicago, Ill.

1,010,265. BLAST-FURNANCE. CHARLES FRANCIS JENKINS, Washington, D. C.

1,010,388. VACUUM-PRODUCING MACHINE. JAMES B. KIRBY, Cleveland, Ohio.

1,014,400. FLUID-METER. EDGAR P. COLEMAN, Buffalo, N. Y.